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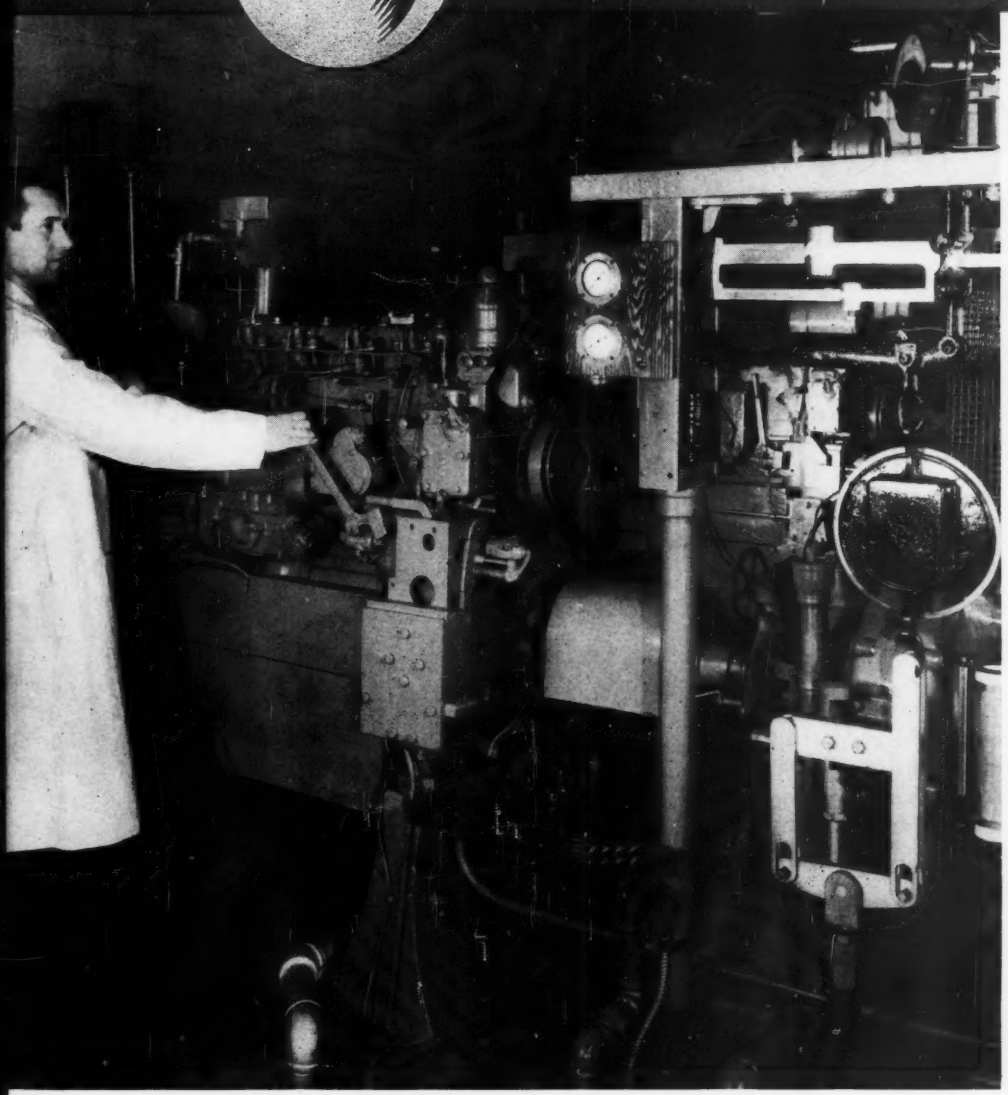

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Typical test set-up for determining characteristics of oils used in internal combustion engine crankcases.

VOL. 1 ★ NO. 4

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

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Editorial

THE purpose of this editorial is to point out a means of increasing the interest in lubrication engineering education, and to develop a plan for presentation at the coming Spring Meeting of the A.S.L.E. At this meeting a committee should be appointed to carry out the plans suggested herein.

It is the belief of some of us that the committee should be a permanent one, with a Chairman, Vice-Chairman, Secretary and additional committee members, subject to periodic changes of personnel as conditions warrant. It is hoped that representatives of the colleges will take an active part in the work of this committee. It should be noted that Columbia University has been offering a course on lubrication since 1939. There are other leading colleges giving thought to the subject and it should require but little effort on the part of the A.S.L.E. to provide various types and kinds of information that Lubrication Engineers will require.

Education has been an outstanding interest to the Society since its inception. After the preliminary organization plans had been tentatively formulated, thirty-three of the leading colleges throughout the United States were invited to the Organization Meeting. Twenty-three of them replied, most of them favorably. Seven accepted our invitation and five representatives were present at the meeting and took very active parts. Our present Vice-President and the Secretary-Treasurer are members of college faculties.

In the By-Laws of the Society, Article II, stating the purposes of the Society, reads:

"To encourage the active cooperation of industry and the profession in advancing the knowledge and application of the art of lubrication in all its branches, and to institute and participate in projects for the attainment of that result.

"To support and stimulate the study and development of the theory and practice of the techniques of lubrication; to sponsor, carry on and provide facilities for research therein and in the fields of physics, chemistry, mechanics, engineering and other related arts and sciences.

"To accumulate and disseminate to the profession and to industry such authoritative, scientific information as may be available through research, testing, field experience and special study conducted by industrial firms, technical schools, oil companies and recognized authorities relating to development in characteristics and types of lubricants; the use of oils, service performance; methods and control of application; machinery design and matters of lubrication management and procedure.

"To encourage the increase of the fund of knowledge and techniques in connection with the problems encountered in the field of applied lubrication by the professional engineer and those in industry who are directly responsible for the efficient operation and maintenance of machinery.

"To promote higher standards of practice in and more effective recognition of the importance of the field of applied lubrication, both in the operation of machinery and in the improved production of basic commodities."

We propose for consideration the following program as an agenda for the committee: The institution of correspondence courses, group classes and lectures and instruction in the fundamentals of lubrication in high schools and colleges. Any educational institution having a mechanical course should include lubrication in some form or degree. In addition, the American Society of Lubrication Engineers will attempt to serve a useful function through its magazine, Lubrication Engineering, and through a library which will be established in due time. Finally, research programs should be sponsored by the Society.

The subjects to be covered in a program should include chemistry as it may relate to lubricants, additives and metallurgy, practical mechanical engineering including machinery and bearing design, shop practice, inspection trips by students under the direction of the local chapters to observe lubrication applications and, finally, petroleum products and derivatives, including methods of application.

This editorial voices not only the views of the author, but also the suggestions and opinions offered by some of the officers and active members of the Society as well as men in industry, who have expressed their approval of the plans outlined.

All officials—the Presidents, Superintendents, Mechanical and Designing Engineers, Master Mechanics, Maintenance Superintendents, Millwrights, Storekeepers, etc., and their staffs—have an interest in lubrication, whether they are aware of it or not. There is a place in the A.S.L.E. for every kind of organization employing machinery in its operations.

With trained and educated Lubrication Engineers available, lubricants will be more intelligently selected and efficiently applied, resulting in more and better products, prolonged life of equipment, less maintenance burden, fewer interruptions to operation, lower costs, and increased profits.

These thoughts are offered in behalf of those who contemplate becoming Lubrication Engineers. We hope that they may secure an education especially adapted to their profession and at the same time enough practical training to enlarge their knowledge and enhance their value to industry.

WALTER D. HODSON.

Heavy Duty Detergent Engine Oils*

By C. R. SCHMITT

Lubrication Manager, Central Division, E. F. Houghton & Co.

Single cylinder Caterpillar engines used for testing under CRC Designation L-1 and L2.

IN DEVELOPING the theme of a subject of this type, I believe it is well to briefly review the background surrounding the development of the "Heavy Duty" detergent crankcase oils and their applications to internal combustion engines, both gasoline and Diesel types. Prior to the year 1936, it was felt generally throughout the oil industry that there was a place for additives in motor oils, particularly where the service on vehicles was of such severity as to demand more than ordinary protection against oil deterioration and engine break-down. It was in 1936, however, with the advent of high speed Diesel engines that the need became acute and the detergent oil first made its appearance. The prime objective of the additive manufacturer at that time was to relieve ring sticking which was caused by abnormally high ring belt temperatures encountered under high speed, heavy-duty service and allow the engine to operate satisfactorily. Because of the necessity of focusing attention on ring sticking problems, very little thought was given to such properties as corrosion, oxidation and film strength of the oil. The engine for which detergent oil was primarily perfected was of the type employing babbit bearings and, of course, inasmuch as these bearings were not sensitive to acid formations in the crankcase oil, corrosion was not a factor.

It was necessary, therefore, to confine the use of this oil to that of a similar type of engine since, if the oil were used in the presence of sensitive alloy bearings, corrosion would quickly result and bearing failure occur. It is generally conceded today that not enough attention was given to this particular point and the user of the oil was not sufficiently or fully advised as to this shortcoming. Consequently, when the oil was used in this engine and proved so satisfactory in eliminating deposits, it was often erroneously recommended for other types of engines to relieve ring sticking. Such misapplications, especially in engines using alloy bearings almost invariably resulted in failure and condemnation of the oil, this condemnation being brought about, of course, by bearing corrosion.

Another factor which accounts for some of the reluctance found today toward accepting detergent oils as satisfactory crankcase lubricants is the fact that very little attention was paid to the development of a suitable base oil for use with the additive. Oils generally accepted at that time as being satisfactory for high speed Diesel use were usually naphthenic or asphaltic because of their tendency towards low carbon formation. In addition to low carbon formation, the carbon formed was of a light, fluffy type, easily disposed of, for the most part, through the exhaust, leaving comparatively little to interfere with ring action or to accelerate liner or cylinder wear. In the use of these early accepted oils to reduce ring sticking, properties affecting oil consumption and service life were subordinated to the main objective. For this reason, in an automotive fleet where gasoline engines were being used in conjunction with Diesel engines, it was usually the practice to confine the use of a detergent oil to the Diesel engines while using a higher grade of crankcase oil in the gasoline engines where other qualities would be reflected in the operation.

Heavy Duty Detergent Oils for Diesel and Gasolines engines—the history of their development, how they function and how to use them are well described in this informative article.

At the end of the year 1937, complaints were being generally recorded in certain types of gasoline engines in heavy duty operations from the standpoint of varnish formations and bearing corrosion. Concurrently, the trend of engine manufacturers was toward alloy bearings. The detergent type engine oil being marketed at that time was not satisfactory for use with these bearings and it became apparent that in order to guarantee the best performance, an oil employing additives which were of a non-corrosive nature would be necessary. New additives containing oxidation and corrosion inhibitors were developed and tested and found to be suitable for use in all engines. The Caterpillar Diesel was representative of the extreme range of operation incorporating high piston temperatures which resulted in piston ring and valve sticking, carbon deposits and the like. The General Motors Diesel, on the other hand, introduced high crankcase temperatures and was conducive to bearing corrosion and formation of varnish. Thus it

** Presented before the September 21st meeting of the Pittsburgh Section of the A.S.L.E.*

Detail of Piston after Failure on High Grade Mineral Oil.

was felt that if an oil was found to perform satisfactorily in both engines, it should be satisfactory for use in any other type of engine lying between the two extremes.

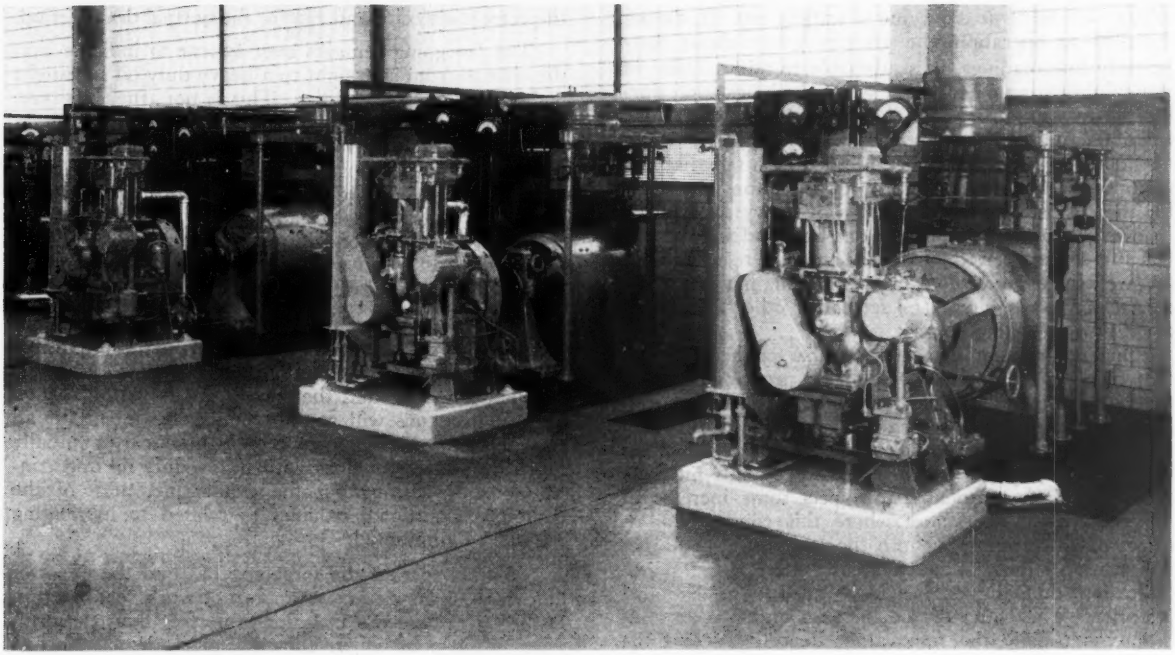
It became quickly apparent that the ordinary laboratory "glass ware" tests were of little value in predicting the service performance of an oil containing additives. After some experimentation, standard engine tests were evolved using Caterpillar, Chevrolet and the General Motors two-cycle Diesel as standard types. These tests are of such severity as to accelerate oil breakdown and predict in a relatively short period what might be expected in actual field service. The various engine and bench test procedures representing present official methods have been developed by the Coordinating Research Committee and are described elsewhere in the literature.

There has been considerable discussion and debate concerning the relative merits of detergent crankcase oils for use in various types of engine operation. However, in my opinion, it is necessary to revert to fundamentals and examine the theory behind the functions of the detergent type oil in comparison with that of the straight mineral oil. In an engine, during normal cycles of operation, there is considerable heat, agitation, presence of oxygen, contact with dissimilar metals, and contamination by various foreign materials. In order to keep the engine running, it is apparent that two things are absolutely necessary, namely, the maintenance of the bearing material in order to insure proper reciprocation of the piston and connecting rod and secondly, the maintenance of adequate seal between piston and cylinder to insure proper compression and efficient power. In order to satisfy the first condition, it is necessary to use additives which are non-corrosive to begin with and which will not become corrosive during use in the crankcase. It is further desirable to employ additives which will protect the bearing from the harmful effects of foreign contaminations which may be corrosive by nature. These contaminants may be formed from burned and partially burned particles of fuel finding their way into the lubrication system.

The second condition is satisfied by employing oxidation inhibitors and detergent materials which will retard oxidation of the crankcase lubricant and thus slow up the formation of varnish forming materials which would otherwise form under severe conditions. The detergent additive functions by acting immediately on tiny particles formed by oxidation of the fuel or oil. This is accomplished by the detergent surrounding each particle with a film which insulates it from like particles and holds it in suspension in the body of the oil. Many of these detergent-surrounded particles are so tiny that they will go through all but the very finest of filters and therefore may add to the discoloration of the oil. Exhaustive tests have proven that they have no deleterious effect on the wear rate of the engine. This is doubtless due to the fact that being very tiny, they pass through even the finest clearances between rubbing parts found in today's engines. Because each particle is coated with a detergent film, it is apparent that over a period of time the oil will lose its drastic detergent properties. However, this time is sufficiently long enough even under the most severe conditions, so that it is not a factor.

In the case of an engine lubricated by a straight mineral oil, these deposits, which are at first unnoticeable, accumulate and build up on various engine parts until they reach a point where they become troublesome.

This view illustrates the excellent correlation between results obtained from full-scale and small-scale engine tests. Pistons at the left were tested with untreated oil, pistons at the right with detergent type oil.



A batttery of single cylinder test engines used to predict service characteristics of crankcase oils prior to testing in full-scale engine.

It is at this point that the operator of the unit notices difficulty in maintaining proper power and engine performance. The lack of effective detergency in a straight mineral oil has been demonstrated time and again in full scale engine tests where straight mineral oils failed under the same conditions in which a detergent oil of the proper type did an excellent job.

An additional feature of heavy duty motor oils is the oxidation resistance imparted by inhibitors present in the additive. These inhibitors act to insulate the oil from the action of air in the crankcase under conditions of high temperature and in close association with various engine metals. This retarding of oil oxidation is apparent in the reduction of viscosity increase or thickening of the oil in service. With straight mineral oil, it is not uncommon to observe a change in viscosity of an SAE 20 oil to the consistency of an SAE 40 or 50 oil after a normal period of service. This is not only detrimental to the engine insofar as proper lubrication of closely fitted parts is concerned, but because it is an indication of oxidation and the probability of engine deposits which later may give trouble.

The early types of detergent motor oils were characterized by troublesome foaming which they exhibited in certain types of operation. This has been corrected and today's heavy duty oils have no more foaming tendencies than do any of the high quality, straight lubricating oils.

There has been considerable confusion in the field regarding the use of heavy duty motor oils in engines which have been previously lubricated with straight mineral oil. It is acknowledged that the ideal engine in which to use a detergent oil is one that is new or rebuilt and is in a clean condition. Under such circumstances, with adequate drain periods and proper maintenance, the detergent oil will maintain cleanliness and, in that manner, insure satisfactory performance throughout the life of the engine.

Most of the objections to the use of detergent oils come from operators who have been led to believe that they are cure-alls or miracle products which, when used in an engine which is already dirty or mechanically inefficient, would bring new life and elimination of mechanical troubles. This obviously is an incorrect conception and every effort on the part of oil marketers should be directed towards correcting it. By its very nature, the true detergent heavy duty oil tends to absorb particles of oxidation and hold them in suspension within itself. Therefore, when introduced in a dirty engine, it immediately works on these deposits and will become prematurely contaminated and prompt draining is necessitated. It has been the practice of most oil engineers to recommend early drainings of detergent oils from dirty engines, the number of these premature drainings to be based on the engine condition.

It is not a reliable guide to base the drain interval on the appearance of an oil inasmuch as detergent oils will absorb sooty particles and darken early in the service period. A method which may be a useful guide in determining proper drain periods is to check the filter cartridge and note when deposits accumulate to the extent that they restrict oil flow through the filter. It is especially important to change filter cartridges with each oil change. It has been our standard recommendation where detergent oil is used in engines which are known to be dirty, that the first oil change be made at least one quarter of the regular drain schedule. Subsequent drain periods should be at one-half normal schedule followed by a three-quarter normal change and then a period of regular operation comparable to that of the oil formerly used. Where service conditions allow, we often recommend the use of a purging or flushing oil in an engine prior to the use of a heavy duty oil. In flushing engines, we recommend that they be filled to two quarts above level and run at a fast idle for a period of an hour or two in order to allow adequate time for complete dissolving of all deposits, particularly those in the crankcase. This flushing is especially effective when the engine is kept in a hot condition. Our experience has been that best results were obtained when the temperatures are 180 to 190 F. After flushing, the oil should be drained immediately in order to remove all materials held in suspension or solution. If allowed to settle and cool, much of the work which has been done by the

solvent will be of no avail due to settling out. If, during the flushing operation, the pressure gauge shows dangerously low readings, it is advisable to add a quart of heavy lubricating oil to insure adequate lubrication during the flushing operation. All flushing should be done while the unit is standing.

Following the flushing operation, we urge that the same precautions with regard to premature drainings for the first two or three charges of heavy duty oil be followed, namely one-quarter, one-half and three-quarters full service period. In every case where users have followed these precautions, no complaints have been received due to clogging of oil screens or other restrictions of oil flow to engine parts.

One other point which should be touched upon is that of oil consumption. Despite the progress made by the petroleum industry in developing lubricants, no oil has yet been produced which will replace metal in worn engines. Where the purging oil or the heavy duty oil has removed deposits which served to partially fill these clearances, it is reasonable to expect some increase in oil consumption. In cases where this consumption is traceable to oil pumping into the combustion chamber and consumption is thereby greatly increased, it is an indication that the engine is in need of mechanical attention. The cause of the increase under these conditions is usually the removal of deposits around the piston rings. These deposits, prior to their removal by the detergent oil, served to lock the rings tightly against the cylinder wall, thus preventing oil escape. Under these conditions, savings of oil is being accomplished at the expense of cylinder and piston wear and is certainly not economical. Very often the increased consumption noticed during the initial use of a heavy duty oil is gradually reduced as the oil continues to perform its functions. Sometimes a piston ring, which is tight in its groove, will become partially loosened and, because it is not flexing entirely around the circumference of the piston, will allow some oil to escape until it is completely freed. After being freed, it forms a complete seal and effectively reduces oil consumption.

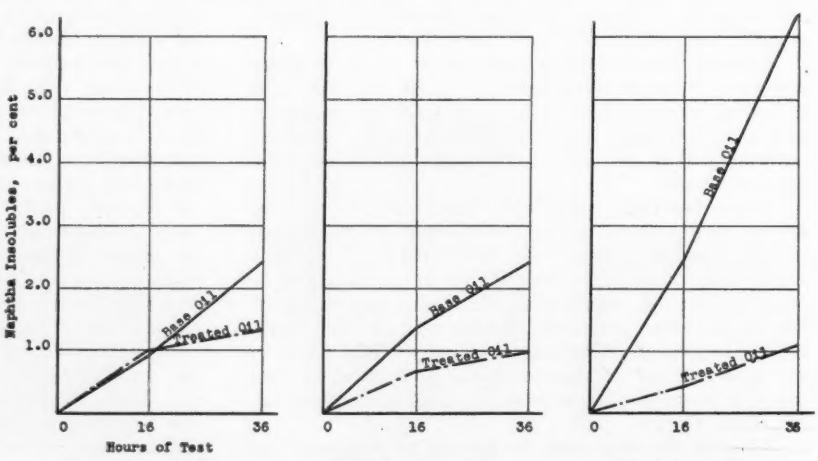
Another factor which may contribute to oil consumption is when piston rings are freed through the action of the oil, thus increasing compression and eliminating or reducing the tendency for oil to be pulled up into the combustion chamber. This, under vacuum conditions, will have a tendency to draw oil up past valve stems, between the stem and the guide, especially in the case where there is considerable valve guide wear or where some of the valves are not seating properly. This would be especially noted, particularly in gasoline engines on downhill runs where the driver removes his foot from the accelerator causing a partial vacuum in the combustion chamber.

In new or rebuilt engines it is recommended that heavy duty oil of light viscosity be introduced into the engine crankcase and the engine idled for approximately two to six hours. After this initial idling period, the unit should be tested under light load for an equal period. The break-in oil is then removed and replaced with oil of the correct viscosity and run for the normal drain period.

The foregoing remarks may appear to indicate that the change from a straight to a heavy duty oil is fraught with dangerous possibilities. This is not true, however, since such precautions are necessary in order to obtain the maximum benefits which may be expected from the use of heavy duty engine oils. It has been our belief during the period of development of this product that the only certain way to gain general acceptance is to acquaint the consumer with all the facts concerning its use. Full satisfaction with these oils can be guaranteed only through intelligent application.

There are a great many variations in the conditions surrounding the use of heavy duty oils. It is impossible to cover all of these conditions at this time. It is my opinion, however, that the time is not far distant when all crankcase oils will contain similar treatment for all types of service. When it becomes practical to initially lubricate all new engines with heavy duty oil and continue its use throughout the engine life, most of the common operational troubles as related to lubricating oil will be eliminated.

It is hoped that the foregoing has had the effect of emphasizing the extensive amount of work performed in testing crankcase oils in order to perfect their performance to the point where they will give adequate factors of safety under severe field conditions. Intensive cooperative thought has been given to this problem of engine testing with regard to lubrication by both members of the automotive industry and the petroleum industry. There is, admittedly, a great deal left to be accomplished in a field where conditions and problems are so many and varied. Accurate lubricant testing, guaranteeing results which can be reproduced, can only be accomplished with expensive equipment and the acquiring of trained personnel whose experience enables them to set up equipment and accurately interpret results. Great strides have been made in the improvement of crankcase lubricants in the past nine years. Lubricants which are accepted as commonplace today were being discussed and talked about as only a possibility a few years ago. The alloying of ideas emerging from further cooperative work between the mechanical and petroleum industries holds great promise for future development.



Pennsylvania Type Conv. Ref'd. | Mid-Continent Type Solv. Ext. | Naphthenic Type Solv. Ext. Coastal.

Effects of Additive Treatment on Base Oils of Various Types.

Engines and Oils in Wartime Britain*

By OSCAR C. THOMAS

General Motors Overseas Operations

OVER three years ago, I arrived in England with a large group of American civilian technicians for the purpose of helping the British Armed Forces to get the best possible results from American-made war products.

My specialty is the Diesel engine, and I use the term "Diesel" to mean any compression-ignition engine. In England I also qualified as an expert, because the British say that "An expert is a mechanic who is a long way from home."

To have lived in the British Isles during the past three years of war was an unusual opportunity to understand and appreciate the British people. The British and the Americans do not understand each other any too well even now, but they are trying hard to be friendly.

One unusual gesture of international friendship is reported to have been prompted by the British National Fire Service. The Fire Service Band had played all one evening to entertain the American troops in a nearby army camp. As

is customary, the Fire Service Band was concluding their program by playing what they thought to be the American National Anthem. When the British musicians began to play, all of the American troops arose and stood solemnly at attention to the tune of "Yankee Doodle Dandy."

As a gesture of good will, General Motors and the United States Navy provided a genuine United States Thanksgiving Dinner for all the technicians in London, in 1942.

During the cocktail hour, preceding the dinner, each of us was introduced to our British Commander-in-Chief, Lord Louis Mountbatten. Admiral Mountbatten introduced me to Lady Mountbatten and then he talked to me for about 15 minutes and asked me many questions concerning my duties in the sea ports. At close range his appearance would compare well with the most handsome movie actors.

At the dinner, the presiding British Officer was our Engineering Chief. Rear Admiral Marc-Wardlaw. The seating was alternately one British Navy Officer, one United States Naval Officer, and one civilian technician. We all ate more than was good for us. I think the Britishers enjoyed the food even more than we Americans, because it had been years since they had seen such a treat. Had they not known that the United States Navy brought the turkeys, the Britishers would have suspected some one of having killed off the Royal swans at Buckingham Palace.

I appreciated these opportunities to meet my fellow technicians and exchange experiences with them.

In 1942, the British Commandos, or Combined Operations, was a special unit of the Armed Forces in which land, sea, and air forces were combined under the leadership of Lord Louis Mountbatten. Preparatory to invading North Africa and Europe, Combined Operations was to receive large quantities of American-built landing craft, most of which were powered with 2-cycle Diesel engines.

At that time, very few Combined Operations personnel were qualified for Diesel engine maintenance or spare parts supervision. Skilled Diesel personnel were scarce in the British Isles for very good reasons.

Spring Convention of A.S.L.E.

Plans are now being completed for the Spring Convention which will take place April 5 and 6. Headquarters will be at the Stevens Hotel. An interesting program of technical papers and discussion sessions is being drawn up. Make your plans now to attend the National Meeting. Preliminary programs will be mailed members of the Society in the near future.

** Presented at the October 31 meeting of the Cleveland Section of A. S. L. E.*

Before the outbreak of the war, the Royal Air Force recruited most of the trained engine mechanics from every part of Britain.

At the outbreak of the war, the motor transport and tank units drafted all the remaining men who were familiar with parts and service procedure. These draftees were skilled in such mechanical products as vacuum cleaners, sewing machines, and refrigerators.

The majority of British people do not own automobiles. The average young man in the British Armed Forces is much less familiar with internal combustion engines than is the average American.

Engineers in the British Navy were very familiar with steam power. British engineers understood their own 4-cycle Diesels, but American high-output, 2-cycle Diesels were comparatively unknown in Britain.

In 1942, the United States government contracted with several American manufacturers to furnish technical service specialists who would train the United Nations instructors on American-made war products.

Service specialists were selected in the U. S. A. and applied to various field duties in each theater of war. The United States Army officially designated such specialists as Technical Observers. Each technician complied with the Geneva Convention by wearing the uniform of a U. S. Army or Navy officer, but with special insignia.

Civilian Technician Application

Upon arriving in Britain, the Civilian Technicians worked in the U. S. Navy office at Combined Operations Headquarters, Whitehall, London. Here we prepared the courses of instruction which were applied in Navy bases all over the country.

Workmen in major overhaul shops were taught the correct procedure for reconditioning our engines.

We planned buildings in which to store spare parts and instructed the British personnel in the correct distribution procedure for spare parts.

In the principal receiving ports, where landing craft arrived from U. S. A. as deck cargo, the Technicians observed the harmful effects of stormy weather on our engines during the ocean voyage.

Technicians assisted in planning and conducting dock trials and river trials preparatory to sending new craft on long coastwise ferry trips to training bases. Because every craft was sent away with a new crew, and because of the urgency of craft dispatch to clear the port, the Technicians found it necessary to instruct largely by actual demonstration aboard the craft during trials.

In addition to receiving new craft, British ports received damaged craft returned from battle operations. This repairing was under the control of a Royal Navy Repair Overseer, usually an Admiral, who employed different civilian contracting firms to do the work. Technicians were used to instruct these different contractors in the correct removal and reinstallation of our engines.

How did our equipment stand up? How did it take the gruelling punishment during the invasions? What were some of the unforeseeable conditions under which it had to operate? These, and many other questions regarding the two-cycle Diesel engines used on landing craft are answered by a service specialist, or, more officially, a "Technical Observer" who helped to keep them running.

Preventative Maintenance

Our experience with the British and with the United States Navy has shown that landing craft engines cannot be adequately maintained simply by instructing the crew. The engine crew can be taught to follow the recommendations in the manufacturer's manuals, but the crew does not plan the work assignments. The craft commanding officer, with the authority to detail the crew to their various jobs, is not a trained engineer. The officer has neither the time nor the inclination to study the engine manuals.

We appealed successfully to the Admiralty to issue Fleet Orders on periodic maintenance which obliged the craft commanding officer to perform a specified routine. Even though the officer may not understand the engine details, at least he is under orders to assign the trained engine crew to specific maintenance jobs.

Brevity and simplicity were essential in Fleet Orders to craft commanding officers. It was not advisable to copy the maintenance sections out of all our Diesel Engine manuals, and to issue these copied sections as Fleet Orders. It was not advisable because:

(1) The recommendations and routine intervals were not uniform in all our American Diesel manuals.

(2) The manual recommendations were not always applicable to the local conditions under which the craft were actually being operated.

(3) The manual recommendations conflicted with the maintenance policies which the Navy had to adopt for their bases in the British Isles.

A major overhaul is needed more often by the engines on small craft than on large craft chiefly because the same crews rarely remain on small craft as long as they do on large craft. Nevertheless, the Navy required all craft to be kept in the best possible state of readiness for combat duty. This demanded a state of operational fitness far higher than unskilled crews could maintain in Britain for longer than 1000 hours by the engine major overhauls.

Lubricating Oils

In addition to Diesel repair and maintenance problems, an important service rendered by American Technicians was that of acquainting British Naval Officers with those characteristics of crankcase oil which are important in lubricating engines under full throttle conditions.

Wartime demands for high engine output, combined with weight and space limitations, created increasingly severe operating conditions which affected the crankcase oil. The severity of the operating conditions was very pronounced where the higher specific output of a 2-cycle Diesel engine was demanded.

Minor operating complaints were easily aggravated by an insufficient knowledge of the oil problems that were encountered in high output engines.

Suppliers in the U. S. A. could readily deliver a wide choice of crankcase oils, but geographic and economic limitations greatly narrowed the choice of acceptable oils that were available overseas. A compromise in oil selection often was unavoidable. We found that the best insurance against failures caused by unsuitable oil was a closer cooperation with reliable oil suppliers.

British petroleum refiners could supply straight distilled oils which were chemically stable against oxidation at the temperature under which the engine was intended to

operate commercially. The American refiners practice the art of compounding oil to prevent decomposition at the extreme temperatures of maximum power output. At present, either the finished additive oil or the special compounding additives are imported from the United States by British suppliers. Although the British did have additive oils which were compounded in England, the quantity was not sufficient for combat needs. All British compounded oil was used in Diesel powered tractors on open-pit coal mining.

The British oil companies are purchasing various American Diesel engines for further development work on additive oils.

We observed that the Admiralty used several British high speed Diesels in British-built landing craft. These British Diesels were not lubricated with additive oil, but instead used steam turbine oil. Steam turbine oil is naturally resistant to oxidation.

The United States Government specified the additive type of lubricating oil for all internal combustion engines used by the American Armed Forces.

Later, the American practice was likewise adopted in the British Isles. The British Government agreed to specify additive oil for lubricating lend-lease engines used by the British Armed Forces.

American additive lubricating oil for the British Army and Navy gasoline and Diesel engines was imported by the British Petroleum Board either under the U. S. Army specification number or under the corresponding U. S. Navy symbol number in the S. A. E. Viscosity 10, 30, and 50.

Upon its arrival in Britain, the Petroleum Board hired civilian contractors to package the bulk American additive oil and to mark the containers with the Pool designations HD 10, HD 30, or HD 50.

The British Petroleum Board designations HD 10, HD 30, and HD 50 were applied exclusively to U. S. Navy and U. S. Army additive lube oils imported into the British Isles.

All our new landing craft were received, unloaded, tested and delivered by British bases that drew their lube oils from the British Petroleum Pool.

In 1942, there was a tendency on the part of the British Engineer Officers and Naval Stores Officers to supply straight mineral oils for use in American Diesel crankcases.

Upon receiving a new craft from the United States, a British Engineer Officer was likely to consult the manufacturer's instruction manual to ascertain what lube oil was specified. American Diesel instructions were written primarily for the domestic field where keen competition has led oil suppliers to offer their oil selection services. American users can trust reputable oil suppliers with the responsibility for the quality and suitability of the engine lubricants they furnish.

The American engine manual usually specified the lube oil simply as S. A. E. 30. The British Engineer Officer would order from the Naval Stores Officer, but Naval Stores was unable to supply S. A. E. 30 oil. The Naval Stores Officer frequently appealed to a friend of his in some oil company in an effort to identify S. A. E. 30. The oil company friend assured the Stores Officer that his company could supply S. A. E. 30, but did not explain that S. A. E. 30 had nothing to do with oil quality.

The S. A. E. Viscosity Number System classifies oils in terms of Saybolt Universal Viscosity only. Other factors of oil quality or character are not considered. This quality is measured by the Redwood System in Britain and by the Engler System in Europe. Although S. A. E. Viscosity Number System was not familiar to the British operators, it was generally recognized by oil and engine technologists.

The engine operator was confronted with conflicting conditions, namely, hotter fresh water aided the combustion of the less volatile fuels but necessitated higher quality lubricants. Conversely, cooler fresh water eased the lubricating oil oxidation, but necessitated higher quality fuels.

At the outbreak of war in 1939, oil fuels on the British market were grouped into four categories, of which two, Pool Gas Oil and Pool Diesel Oil, are suitable for compression ignition engines. These two are distillates. Gas oil is intended for small high speed Diesels. Pool Diesel oil is specified for medium and low speed Diesels.

Effects of Idling on British Pool Fuel

An important problem encountered at slow idling speeds on Diesel engines was the lack of sufficient combustion temperature to burn all the fuel completely. Failure to burn all the fuel was a pronounced difficulty even when using British Pool Gas Oil.

British Pool Gas Oil has a much wider boiling range than the fuel specified by the United States Government for their Army and Navy. I examined laboratory distillation curves made from several incoming Pool Gas Oil shipments from the U. S. A. and observed final boiling points as high as 750 F. Fuel imported into Britain lately has been much more volatile than formerly.

The lighter components of Pool Gas Oil will burn completely under all engine operating conditions. The heavier components of Pool Gas Oil are harder to ignite under slow idling conditions. The heavy ends of Pool Gas Oil pass through combustion processes unburned. Some of this unburned vapor condenses into a liquid upon reaching the exhaust line because the exhaust line was comparatively cool under idling conditions. Part of this unburned fuel escaped past the pistons and diluted the lubricating oil.

In some installations, the exhaust line ran horizontally or even upwards from the engine permitting the condensed, unburned fuel to flow back after the engine had stopped. This unburned fuel flowed back through the open exhaust valves into one cylinder where it oftentimes seriously damaged the engine when it was restarted.

At least four major fires occurred on LCT (5) craft as a result of unburned, condensed fuel seeping through exhaust line flange joints and into the heat insulating lagging around the exhaust piping. Such fires were particularly difficult to fight. They rarely occurred until the exhaust line had been up to full heat for three or four hours, or until the craft was well away from help on shore.

Effects of Idling on Battery Charging

Many landing craft were unloaded at Liverpool and ferried across England from west to east through the Leeds-Liverpool Canal. The canal was shallow, necessitating craft operation at slow speed.

One disadvantage of prolonged slow idling of the engine was that the cutout relay in the battery charging system was continually opening and closing the circuit. The relay cut out at 400 rpm to 500 rpm on our Diesels.

Frequent cutting in and out of the relay eventually caused the contact points to stick together. The battery current then drained away through the stuck contacts. During all idling periods, the engine had to be run at whatever minimum speed gave the maximum charging rate on the ammeter. On our Diesels, the maximum charging rate of 15 amp. with a low battery was attained at engine speeds of 900 rpm to 1000 rpm.

Engine Performance

Most of our troubles in the British Isles were due to personnel or scarcity of spare parts. The engine complaints were the normal expectations in this abusive type of Marine service.

Practically all Diesel engine failures on landing craft occurred as a result of unskilled operation. Nearly every new engine operator makes a major mistake once, which results in engine failure. Such a failure may never be repeated with that particular crew member, but the men were transferred constantly.

Diesel powered landing craft in the Mediterranean did not encounter any mechanical troubles that were new or baffling or had not been experienced previously in craft operations around the British Isles. Geographic influences accounted for the few differences there were in craft performance. For example, sea water suction strainers clogged more often in the Mediterranean, but more propellers were bent in operations in Scotland. In general, the major engine problems in the Mediterranean were simply aggravated examples of the same problems previously encountered in the British Isles.

About half of the engine room complaints were caused by the injurious effects of salty atmospheric air on electrical equipment. Landing craft were fitted out with some water proof, regular Navy wiring. Most of the craft's electrical equipment was of the ordinary, air ventilated, unprotected type which is very susceptible to salt water effects.

Scarcity of tools and parts so prevalent in the British Isles accounted for many engine failures, because needed spare parts could not be obtained when the trouble was in an easily corrected stage.

We compared all technicians' reports for trends indicating epidemics of troubles. We questioned the technicians separately to round out our understanding of the problems they encountered. After sufficient investigation, we often discovered that a major complaint vanished when the local authorities really took the matter in hand.

The British Armed Forces agreed that American Diesel engines served in every operation without an epidemic of any one class of mechanical failure.

Damage by enemy action, injury during removal from craft to overhaul bases and maltreatment by unskilled workmen were the principal causes for replacing engine parts other than causes from normal wear.

The automatic flow of spare parts from the U. S. A. was intended to relieve all critical parts shortages. Although we saw evidences of relief in the parts situation, the quantity of parts received on automatic flow was not always in line with actual parts usage replacement during overhaul.

Parts availability was often so critical in engine overhaul shops that a rebuilt engine could not be tested or shipped until a worn engine was received and robbed of various parts necessary to complete the rebuilt engine.

We could not blame the American factories, the product design or the automatic flow of parts from the U. S. A. Nor could we blame the local authorities for mismanagement. The British found it necessary to refit a large quantity of landing craft preparatory to invasion. The spare parts demand simply exceeded the supply. Given sufficient time, the situation would have corrected itself.

The automatic flow of parts from the U. S. A. was based on the idea that engines would be overhauled at regular intervals. Instead, the entire British invasion fleet underwent refitting at one time.

Training Mechanics

From my experience in training both British and American mechanics, I observed interesting differences in their national traits. I do not refer to skilled British mechanics in the RAF and other motorized units. Instead I refer to the clothes pressers and pastry bakers who were drafted into Combined Operations for landing craft duty.

American lads, like Andy Hardy in the movies, grow up with easy access to automobiles. When trained as mechanics they are taught the use of all sorts of special tools and equipment. Under war emergencies, special tools and spare parts often are in short supply.

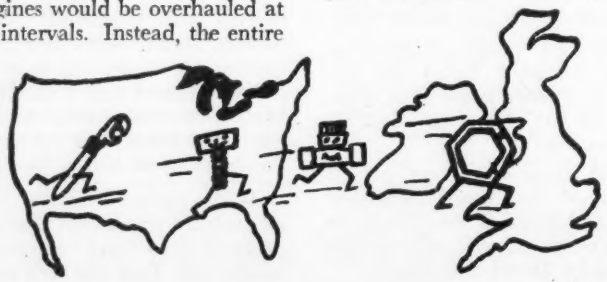
When the American lad does not have some vital spare part to meet an urgent need, he persists until the required supplies are obtained. Often his persistence makes him become thoroughly obnoxious to everyone concerned.

The British lad does not expect any help. He starts immediately to improvise the needed parts from the materials and tools at hand. A screw driver, a pair of pliers and an adjustable wrench are often his only tools.

British lads have a very direct approach to unexpected operating problems because they are not handicapped by too much engine knowledge. I confess that I learned a great deal from watching British lads apply their novel methods to our engines. Sometimes I suffered twinges of pain when they unwittingly abused expensive machinery.

Although the British lads were direct in solving problems, their sisters serving in the Royal Navy as WRENS are still more direct in getting to basic facts. A WREN in one of our engine school classes was asked to name the four strokes of a 4-cycle engine. She replied, "Suck, push, bang, blow."

Large quantities of WRENS were employed by Combined Operations for engine reconditioning and spare parts distribution. WRENS were



also used as landing craft crew members when eligible boys became too scarce. I sympathized with these girls when I first saw them in a Commando camp working knee deep in the ocean while they scraped the bottoms of landing craft, and shivered in the Scottish winter wind and rain.

The success of Marine craft operations on and after "D-Day," is a tribute to the ingenuity and resourcefulness of young engine operators. Also, it is a fact that no small part of the success may be attributed to the dependability of many thousands of American-built Diesel engines.

Service Record

When all the war records can be told, the part played by Diesel engines will command attention, both as a great public service, and as a noteworthy advancement in a highly essential industry.

The record will be found significant not only because Diesel engines solve power problems for the Army and Navy, but because their war time service already indicates that Diesel engines will expedite the reconversion of industry in this post war world.

Diesel power makes the best showing on severe jobs where the loads are heavy, the service is abusive and the operation must be highly dependable. Americans consider that the use of Diesel power is justified only when the job is big enough to earn its first cost quickly. The small Diesel engine is not likely to be used in American automobiles because more suitable gasoline engines are available.

The British use of Diesel power is stimulated by the necessity for utilizing heavier and cheaper fuel than gasoline. Accordingly, the British have spent a great deal of developmental effort on small-bore 4-cycle Diesel engines. The British may be justifiably proud of their excellent Diesel progress.

In Britain there are special requirements which are best met by Diesel power. The present British 4-cycle Diesels are the result of many years of careful work. They must be accepted as the best commercial solution for the conflicting factors of manufacturing cost, fuel economy and durability.

LETTERS TO THE EDITOR

Editor, Lubrication Engineering:

Communications received by me relative to my paper, "Semi-Boundary Lubrication with Long-Chain Polar Compounds" in the October quarterly issue of LUBRICATION ENGINEERING, suggest that it would be worthwhile to provide additional information relative to the significance of the Falex failure load values reported.

As those who have worked with the Falex machine will realize, the reproducibility of failure loads with a given lubricant may vary over a considerable range. This variation is apparently associated in some manner with the quality and condition of the test pieces, and often has been observed to correspond with the particular shipments of test pieces as received. Previous experience having shown this to be true, our published investigations have been planned around experimental work conducted along "family unit" lines. For example, Table I, page 63 of the publication, lists the Falex failure load values for a family of eight normal alkyl esters. The number of test pieces required to carry out six duplicate determinations with each of the 24 lubricants (three concentrations each with each of eight esters), summarized in Table I, were calculated. The required number of test pieces were then selected from the various available lots and thoroughly mixed. All test pieces required for the unit of Table I were then selected from this one lot of test pieces. This procedure, coupled with the use of the averaged results of six duplicate determinations, has been found, on the basis of several years' experience, to provide relative data capable of consistently reasonable duplication. This procedure does not insure, however, that the absolute magnitude of the failure load will be reproducible, as this value will continue to fluctuate with the various lots of test pieces employed. However, the purpose of the paper was not that of comparing the absolute load bearing values of the various long-chain polar compounds investigated, but rather to study relative differences among different members of a given type of additive with variations in chemical structure. Thus we would expect that independent groups of investigators using our procedure would be able to confirm our results insofar as the relative ratings of the individual units within each family are concerned, but not necessarily with respect to the absolute failure load values.

The author also has knowledge, through private communications, that there may be other improved ways of securing more satisfactory reproducibility even with respect to the absolute failure load values among independent investigators using different Falex machines. It is hoped that the Society will be in a position to publish such information at an early date.

The presently available equipment for studying lubricating characteristics under semi-fluid and boundary friction conditions is admittedly not ideal. However, we feel, at the same time, that the potential merits of this equipment may be overlooked because of admitted difficulties in obtaining the best reproducibility.

E. M. KIPP.

Problems in Industrial Lubrication*

By F. W. KAVANAGH

California Research Corporation

In this paper the author divides industrial lubrication problems into five categories, and sets forth the fundamental lubrication requirements of each one, then goes into detail concerning certain specific and interesting problems.

Introduction

DURING the past three decades we have witnessed the development of the automobile, the airplane, and the Diesel engine. Many lubrication problems were encountered during this development, and most of the technical journals have devoted considerable space to articles describing investigations of carbon formation, oil consumption, ring sticking, engine wear, cold starting, and other problems of the automotive and aircraft industries. By comparison, the field of industrial lubricants might seem to have been neglected, although its problems have been more numerous and more varied. In fact, industrial lubrication involves practically every known mechanical device, and almost everything that moves requires lubrication. Industrial lubricants are also important economically, because more than half of our national production of oils and greases is used in industrial equipment.

Chart 1 shows the total consumption of lubricants, the amount used in automotive equipment, and the amount used industrially for each year since 1930. These data were taken from the A.P.I. quarterly of July, 1941. In the case of automotive lubricants, the yearly consumption decreased from 509 million gallons in 1930 to 459 million gallons in 1940. This was caused largely by improvements in the oil consumption characteristics of modern engines and is illustrated by the fact that the gasoline to oil ratio increased from 29.2 in 1930 to 48.0 in 1940. While the automotive lubricants decreased about 10% during the last 10 years, the annual consumption of industrial lubricants increased from 398 million gallons to 577 million gallons, a gain of 45%.

* *Presented before the September meeting of the Petroleum Group, American Chemical Society, Oakland, California.*

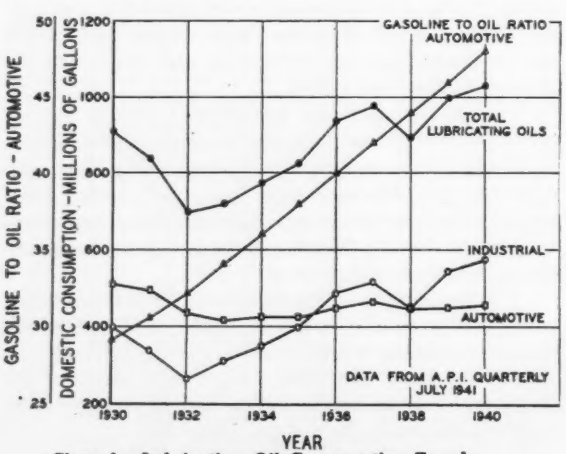


Chart 1. Lubricating Oil Consumption Trends

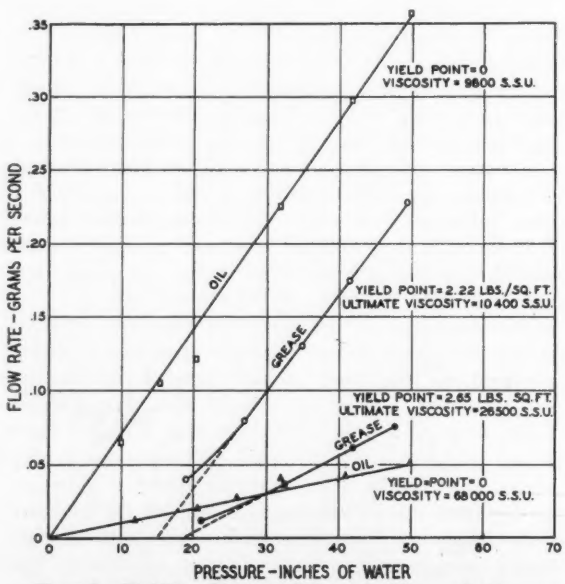


Chart 2. Fluidity Characteristics of Oils and Greases

Definitions

The word "lubricate" is defined by Webster as "to make smooth or slippery." In discussing various lubrication problems, the terms "viscosity," "oiliness," and "film strength" will also be used. These may be defined as follows:

Viscosity is probably the most important single property of a lubricant. It may be defined as resistance to flow, and for oils it follows the simple law: S=ZR, where S equals the shearing stress, Z the viscosity, and R the rate of shear.

Oiliness is that property of a lubricant which affects the coefficient of friction for condition of metal to metal contact, and is independent of the viscosity. High oiliness means low friction. Oiliness may also be called lubricating value and is a function of the molecular structure of the oil. Many addition agents are added to oils to increase oiliness, the most common being fats and fatty acids. In theory, the fatty acids operate by adsorption, with the polar ends attracted to the metal and the hydrocarbon chains extending perpendicularly away from the surface. Small amounts of these fatty acids have a very marked effect on oiliness for certain operating conditions; such as low speeds and high temperatures.

Film Strength or load carrying capacity of a lubricant is the maximum load that may be applied to relatively moving surfaces, lubricated by the oil or grease being tested, without metal seizure. In general, the term film strength applies only to the use of the lubricant on ferrous metal surfaces. Uncompounded lubricating oils do not have sufficient film strength for some conditions of heavy duty operation, and special addition agents are added for this purpose, the resultant products being known as extreme pressure lubricants. The action of the compounding material in extreme pressure lubricants is exactly opposite to that of the flux in a welding or soldering operation. Where the flux tends to facilitate welding, the extreme pressure compound acts as an anti-flux to inhibit welding or seizure, by chemically combining with or poisoning the surfaces. Many compounds have been developed for improving film strength. The most common contain sulfur, chlorine, phosphorus, or lead, the first two being the most common for industrial usage.

Oiliness and film strength are not absolute qualities but are influenced to a marked degree by operating conditions. Where these properties apply the coefficient of friction usually decreases as the speed is increased, and increases as the temperature is raised. However, since the amount of heat developed is proportional to the friction and does not decrease fast enough with increases in speed to maintain the heat generated constant, there is always an increase in surface temperatures as the rubbing speeds become higher.

The film strength of a lubricant decreases rapidly as the rubbing speed is increased, because the increase in heat generated facilitates the welding of the rubbing surfaces. At low rubbing speeds the film strength of an uncompounded mineral oil is as high or higher than the crushing strength of the surfaces being lubricated. At high speeds, in the order of 500 to 1000 feet per minute, failures occur at relatively light loads, but a ten-fold increase in film strength may be obtained by the use of active chemical compounds.

The influence of rubbing speed on lubrication is of practical importance, because a lubricant which is entirely satisfactory for a given load at one speed, may allow failures if the same load is applied at a different speed. For example, in cutting threads on a pipe with a hand die, good smooth threads can be obtained with a small amount of straight mineral oil, but under the high speeds of machine threading, these oils are inadequate and special cutting lubricants are required.

Comparison of Oils and Greases

The mineral oils used for industrial lubrication are complex mixtures of hydrocarbons containing small percentages of other compounds naturally found in crude petroleum and not removed during the refining process. These oils generally obey the laws of viscous friction, although there is one type, the thickened lubricants, whose viscosities at high rates of shear are much less than would be estimated from the results of tests in capillary tube viscometers.

Three factors influence the characteristics of various types of lubricating oils; the type of crude from which it is derived, the amount of refinement to which it is subjected, and the compounding material added. The crude and its refinement are closely related, since different degrees of refinement are necessary to obtain similar products using various types of crude. Generally, the oxidation resistance is improved as the amount of refinement is increased, while the oiliness and the film strength are reduced. If, however, the oil is very highly refined, as in the case of medicinal or white oils, the type of reaction with oxygen is changed somewhat and these oils are readily oxidized.

Greases differ from oils in that they are plastic solids and do not follow the same laws of viscous friction. Chart 2 is a comparison of the flow characteristics of several representative oils and greases as measured in a pressure viscometer. It will be noted that the curves for the oils all pass through the origin, whereas with greases, a certain amount of pressure is required before flow starts, after which it proceeds much more rapidly. For this reason, viscous oils will flow readily through screens or small orifices while stiff greases will not flow unless pressure is applied.

Greases are composed of mineral oils thickened with soaps. The amounts used vary from about 1% to as much as 50%. The most common soaps used are sodium, calcium and aluminum, although other metals, such as magnesium, zinc, and barium are also used. The soap in the grease forms a cellular structure that gives the grease its plastic properties. This cellular structure is easily broken and greases, therefore, are thixotropic. In other words, when the cellular structure is broken, the grease becomes more fluid, until sufficient time has elapsed for the soap structure to reform. In this respect greases resemble jelly. A glass of jelly can be turned upside down without spilling, but if stirred, it will pour readily from the container.

Due to the thixotropic nature of greases, their plasticity characteristics, as determined in a capillary tube viscometer, do not represent the maximum values. For this purpose a penetrometer is generally employed. The penetrometer consists of a metallic cone forced into the grease under specific conditions and the values obtained, known as penetrations, express the consistency properties of the grease. High values of penetration indicate a soft product and low values a stiff grease. The resistance of a grease to change in consistency with working is obtained by measuring the penetration after the grease has been forced through a special sieve a given number of times. This property is of primary importance, because in many cases the grease is worked excessively in

operation, and the characteristics of the worked grease predict its service performance.

Generalization of Frictional Surfaces

Although industrial equipment is extremely diversified in nature, its lubrication requirements can be generalized, and it is possible to divide the bearings and other frictional surfaces requiring lubrication into five distinct classifications. They are as follows:

1. Journal bearings
2. Anti-friction bearings
3. Gears
4. Pistons and cylinders
5. Cutting operations

The items falling under the journal bearing classification include partial and complete journals, thrust bearings such as the Kingsbury type and slipper blocks. These bearings have been grouped together because they normally operate under the conditions of full fluid film lubrication. In other words, the load is carried on a wedge-shaped film of oil and the performance is a function of the modulus, ZN/P where Z represents the viscosity, N the rubbing speed, and P the unit load. For most cases the performance can be calculated directly if dimensions and the three factors making up the modulus are known.

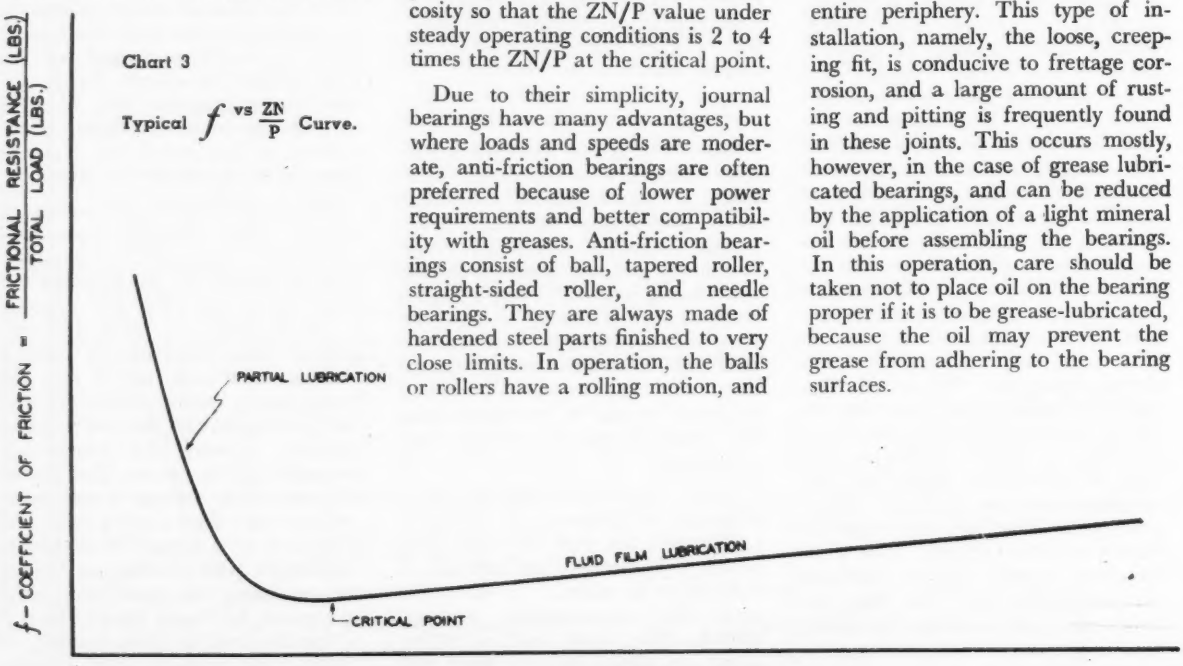
A typical journal bearing performance curve is shown on Chart 3, which illustrates the principles of full fluid lubrication. In the zone to the right of the critical point, the load is carried on an oil film, and there is no metallic contact. This is verified by theory and has been proved by measurements of the electrical resistance of the oil film. As the value of ZN/P is decreased below that of the critical point, more and more of the load is carried by metal to metal contact, and in this zone, oiliness effects are important. Here also, wear is rapid, and bearing life is short. This chart also illustrates the type of lubricant most suited for different operating conditions. For high speeds and light loads it is evident that a low viscosity oil should be used to minimize friction, and that where loads are heavy and speeds low, high viscosity lubricants are required. Thus, if a high speed bearing is operating at too high a temperature, it is probable that the lubricant is too viscous and that the bearing will be cooled if a lighter oil is used. Similarly, if a heavily loaded, low speed bearing shows evidence of excessive temperature, operation may be improved by increasing the viscosity of the oil. In many cases it is desirable to minimize friction, and it is evident from the chart that this can be achieved by operation at the critical point. It is considered better practice, however, to choose the viscosity so that the ZN/P value under steady operating conditions is 2 to 4 times the ZN/P at the critical point.

Due to their simplicity, journal bearings have many advantages, but where loads and speeds are moderate, anti-friction bearings are often preferred because of lower power requirements and better compatibility with greases. Anti-friction bearings consist of ball, tapered roller, straight-sided roller, and needle bearings. They are always made of hardened steel parts finished to very close limits. In operation, the balls or rollers have a rolling motion, and the only sliding friction that takes place is between them and the retainer and the small amount of sliding caused by the distortion of the ball or rollers and the races due to the loading. Since these bearings have only a small amount of sliding friction very little heat is generated at the rubbing surfaces, and their lubrication requirements, in so far as oiliness and film strength are concerned, are not severe. For this reason a continuous supply of almost any type of lubricant on the frictional surfaces will be found adequate.

The most serious problem with respect to the operation of anti-friction bearings is fatigue failure of the parts, which is caused by overloading and is not influenced by the type of lubricant. Another service problem in these bearings is frettage corrosion between the "stationary" race and the shaft or housing. This so-called frettage corrosion is caused by intermittent movements of small magnitude and takes the form of rusting or pitting.. It is probably related to the changes in the chemical activity of adjacent portions of the surfaces due to the stresses. Anti-friction bearings are installed with the rotating race fitted tightly, while the "stationary" race has a loose fit so that it can creep gradually and thus distribute the load around its entire periphery. This type of installation, namely, the loose, creeping fit, is conducive to frettage corrosion, and a large amount of rusting and pitting is frequently found in these joints. This occurs mostly, however, in the case of grease lubricated bearings, and can be reduced by the application of a light mineral oil before assembling the bearings. In this operation, care should be taken not to place oil on the bearing proper if it is to be grease-lubricated, because the oil may prevent the grease from adhering to the bearing surfaces.

Chart 3

Typical f vs $\frac{ZN}{P}$ Curve.


f - COEFFICIENT OF FRICTION = FRICTIONAL RESISTANCE (LBS.) / TOTAL LOAD (LBS.)
PARTIAL LUBRICATION
FLUID FILM LUBRICATION
CRITICAL POINT

$$\frac{ZN}{P} = \frac{(\text{VISCOSITY - CENTIPOISES}) \quad (\text{SPEED - R.P.M.})}{\text{PRESSURE - POUNDS PER SQUARE INCH}}$$

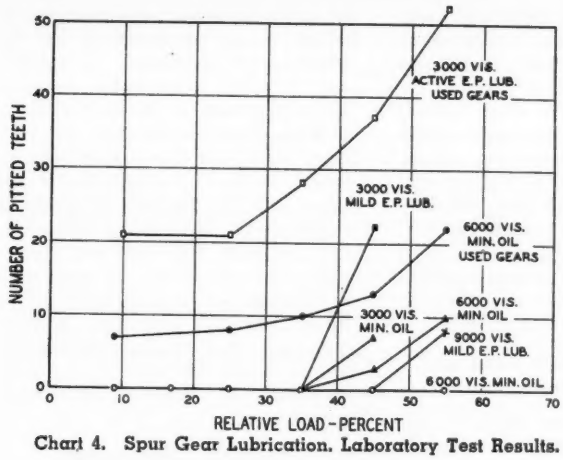

NUMBER OF PITTED TEETH
RELATIVE LOAD - PERCENT
3000 VIS. ACTIVE E.P. LUB. USED GEARS
3000 VIS. MILD E.P. LUB.
6000 VIS. MIN. OIL USED GEARS
3000 VIS. MIN. OIL
6000 VIS. MIN. OIL
9000 VIS. MILD E.P. LUB.
6000 VIS. MIN. OIL

Chart 4. Spur Gear Lubrication. Laboratory Test Results.

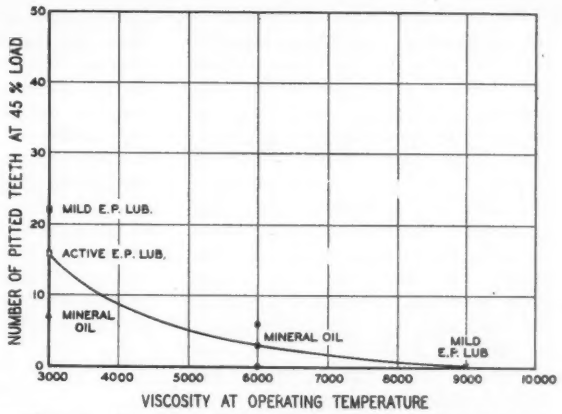


Chart 5. Spur Gear Lubrication. Effects of Viscosity and Compounding Materials.

The third type of frictional surfaces, gears, may be sub-divided into the following classes: spur, herringbone, bevel, spiral-bevel, hypoid, and worm. In all gears, one curved surface is pressed against another, and the contact area between the teeth is small. Consequently, the unit loads may be very high, and values of over 100,000 pounds per square inch are not uncommon. The spur, herringbone, and bevel gears are designed so that the teeth contact with a rolling motion, and the major portion of the sliding friction involved is due to the distortion of the gear teeth under load and at the point of contact. Some sliding friction also exists, due to the fact that gear teeth, particularly when worn, deviate somewhat from theoretical contours. Therefore, even with spur and similar gears a moderate degree of lubricating value is essential since this property is necessary to present friction from becoming excessive when metallic surfaces are rubbed together under heavy loads. It is even more important, however, that the lubricant have a high viscosity in order to cushion and distribute the load more evenly over the contact areas. Laboratory data obtained with different lubricants in a machine having two large spur gears as the test specimens are shown in Chart 4. In these tests the load was raised gradually and the number of pitted teeth was observed periodically. On the chart the load is expressed as a percentage of the allowable load calculated from the strength of the gear teeth. It will be noted that pitting started at loads of 35% to 45% and became more severe as the load was increased. These pits occurred on both sides of the pitch line and were characteristic fatigue failures and not corrosion failures as the designation "pitting" might seem to indicate.

The data from Chart 4, corrected in the two cases where used gears were employed to account for the initial pitting, have been plotted against the viscosity of the lubricant on Chart 5. It is evident from this plot that increasing the viscosity decreased the amount of pitting, probably because of a more even distribution of the load and a reduction in the intensity of the shock loads, both due to the cushioning action of the oil. It may also be noted that the addition agents used were of no value. The mild extreme pressure lubricant had the properties of high oiliness and moderate load carrying capacity, while the active extreme pressure lubricant contained in sulphur compound that reacted with the gear surfaces at a relatively low temperature. The difference between the 3000 viscosity mineral oil and the extreme pressure lubricants of the same viscosity is probably within the range of experimental error.

While compounding materials are of no value for the rolling motion of the spur gears they are very effective for worm gears where a large amount of sliding friction takes place. Laboratory data from worm gear tests are shown in Chart 6. These tests were made under a condition of low speed and high load, and it will be noted that the uncompounded mineral oil allowed an excessive temperature rise and was unsatisfactory. The 3000 viscosity compounded lubricant gave satisfactory results, and even better friction reduction was obtained with the 9000 viscosity compounded oil. In this gear set, the worm was above the gear, and consequently all of the lubricant reaching the worm had to be carried up by the gear. For this reason, an increase in the viscosity of the oil increased the amount of lubricant reaching the rubbing surfaces which would account for the better lubrication and cooling with the most viscous oil. Castor oil is shown in this chart for reference purposes.

Hypoid gears are not used very widely in industry, and where they are used, their operating conditions are much less severe than those in automotive equipment. However, the contact surfaces of these gear teeth have a combined rolling and sliding motion, and since these surfaces are always steel on steel, a lubricant of high film strength is required. For this service automotive hypoid lubricants are generally recommended.

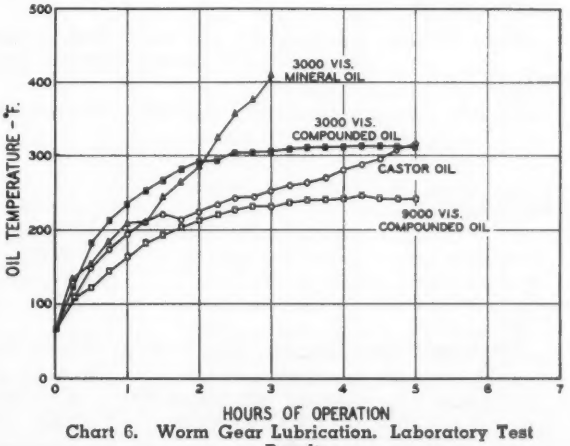


Chart 6. Worm Gear Lubrication. Laboratory Test Results.

Pistons and cylinders present similar lubrication problems, whether they be parts of gasoline, natural gas, Diesel or steam engines or compressors handling air, ammonia, sulfur dioxide, hydrocarbons or other gases. The main purpose of piston rings is to seal gases under pressure, and they are so designed that they accomplish this sealing action where the amount of lubricant is at a minimum. The lubrication of piston rings is thought to consist largely of the fluid film type with some metallic contact, particularly at the head end of the stroke where pressures are highest and speeds lowest.

The requirements of lubricating oils for internal combustion engines include high oxidation stability, adequate detergency, low carbon forming tendencies, and low wear characteristics. Their requirements vary with the type of engine and the service involved and a complete discussion is beyond the scope of this paper.

The fifth type of industrial lubrication, namely, cutting operations, involves a large complexity of cutting tools, cutting speeds, type of metals being cut, and film strength, oiliness, and heat conducting properties of the lubricant. The functions of the cutting fluid are: cooling, flushing away the chips, and reducing friction. This must be accomplished under conditions where metal is being sheared by the tool and comes off in the form of a hot chip with its raw surfaces in a condition conducive to welding or grabbing. For the least severe operating conditions, mixtures of water and soluble oils are generally used. These soluble oils are composed of mineral oils plus soaps that cause the oil to emulsify with water. Cutting oils are required when operating conditions become more severe through increases in cutting speeds, the greater toughness of the material being machined and the difficulty of applying the lubricant to the cutting edge. These cutting oils are of 100 to 200 Saybolt viscosity at 100 F. compounded with addition agents to provide oiliness and film strength.

Choosing Between Oils and Greases

A number of years ago, a large amount of experimental work was done at our laboratories, comparing the service properties of oils and greases in journal bearings. Almost a thousand separate tests were made in this investigation, and the following conclusions were drawn:

1. Oils were generally superior to greases under the following conditions:
   a. Low bearing clearances.
   b. High rotational speeds.
   c. Frequent speed changes.
2. Greases had certain advantages, namely:
   a. Preventing leakage, particularly during idle periods.
   b. Minimizing starting friction.
   c. During intermittent operations.

In these tests no deviation from the general ZN/P relationship was observed for oils. In the case of greases, it was found that the lighter greases were closer to oils in the nature of their performance and that the inherent characteristics of greases became more pronounced as the stiffness was increased. A tabulation to assist in choosing between oils and greases is shown on Chart 7. This chart shows that for very heavy loads and low speeds greases should be used. At high speeds and light loads, low viscosity mineral oils must be used, but for the intermediate conditions both oils and greases may be found suitable. In cases such as bearings with very large clearances, vertical bearings, moving bearings, and similar conditions, greases would be favored. In most other bearings, however, oil is more desirable.

Specific Lubrication Requirements

Besides the generalization regarding types of surface to be lubricated which was discussed above, industrial lubrication problems may be simplified further with respect to the steps to be taken to insure satisfactory results. These steps are:

1. Choosing a lubricant having the proper viscosity or consistency and proper lubricating value for the service involved.
2. Providing a means to supply the lubricant to the frictional surfaces.
3. Maintaining the lubricant in a usable condition.

The reason for Item 1 above is evident, but Items 2 and 3 are influenced to some degree by the lubricant itself. An example is the case of anti-friction bearings where the most important surfaces to be lubricated are the balls and rollers, to

CHART 7 JOURNAL BEARING LUBRICANTS TYPICAL RECOMMENDATIONS

LOAD	VERY LOW SPEED BELOW 25 RPM	LOW SPEED 25 TO 100 RPM	MEDIUM SPEED 100 TO 300 RPM	HIGH SPEED 300 TO 2000 RPM
VERY HIGH Above 500 psi	Roll greases and other heavy, stiff greases	Roll greases Roller oils		
HIGH 500 psi	Greases, No. 5 grade	Greases, No. 3 grade	Heavy oils, above 500 S.S.U. at 100F Greases, No. 1 and 2 grades	Medium viscosity oils, 300-500 S.S.U. at 100F
MEDIUM 300 psi	Greases, No. 3 grade	Greases, No. 1 & 2 grades Heavy oils, above 500 S.S.U. at 100F	Medium viscosity oils, 300-500 S.S.U. at 100F No. 1 grade greases	Light oils, below 300 S.S.U. at 100F
LOW 100 psi and below	Greases, No. 1 & 2 grades Heavy oils, above 500 S.S.U. at 100F	Greases No. 1 grade Medium viscosity oils, 300-500 S.S.U. at 100F	Light oils, below 300 S.S.U. at 100F No. 1 grade greases	Light oils below 300 S.S.U. at 100F

CHART 8

INDUSTRIAL LUBRICATION

EXAMPLES OF SERVICE REQUIREMENTS

Lubricant	Requirements
BALL BEARING GREASE	1. Suitable consistency 2. High melting point 3. Resistance to hardening at high temperatures 4. Ability to feed properly to balls and races
GREASES FOR PACKING GLANDS, CENTRIFUGAL PUMPS	Must lubricate bearing and resist action of liquid being handled. Such liquids include: 1. Water 2. Salt water 3. Hydrocarbons and other solvents 4. Caustic soda solutions 5. Sulfuric acid 6. Nitric acid
CANNERY GREASES	Must lubricate satisfactorily and have the following other properties: 1. Odorless 2. Tasteless 3. Colorless 4. Minimize rusting and corrosive action of fruit juices 5. Resist action of boiling water
DREDGER GREASES	1. Must resist the action of muddy water 2. Must float—gold dredging operations
STEAM CYLINDER OILS	1. Must lubricate cylinders in presence of wet steam, dry steam and superheated steam 2. Must emulsify readily 3. Must wet friction surfaces in preference to water
TURBINE OILS	1. Must be of suitable viscosity 2. Must resist oxidation and loss of demulsibility 3. Prevention of rusting is desirable
ICE MACHINE OILS	1. Must be fluid at low temperatures 2. Must resist oxidation and not react with refrigerants such as: Ammonia — Methyl Chloride Sulfur Dioxide — Freon
COMPRESSOR OILS	1. Must resist oxidation and not form gummy deposits 2. Must lubricate in the presence of condensed moisture
GLASS MOLD OILS	1. Must ignite spontaneously at the temperatures of the molds 2. Must leave a deposit of dry soft carbon and no other deposit
WOOL OIL	1. Must lubricate the wool 2. Must emulsify readily with water 3. Must not gum the carding machines 4. Must be washed from the finished cloth easily 5. Must leave no odor 6. Must not affect the dye
CONCRETE FORM OILS	1. Must be easily spread on forms 2. Must resist the abrasive action of the concrete 3. Must prevent the adherence of concrete to the molds
LAUNCHING GREASES (SLIP COAT)	1. Must have the proper consistency 2. Must be water resistant
(BASE COAT)	1. Must adhere strongly to the ways subject to water action 2. Must have high crushing strength 3. Must have good pliability (prevent cracking when cooled) 4. Must have high melting point (for ease of application under warm weather conditions) 5. Must have firmness without brittleness at low temperature
CUTTING OILS	Must lubricate the cutting tool for various types of metal cutting operations, including: 1. Turning 2. Broaching 3. Milling 4. Boring 5. Thread cutting 6. Gear cutting 7. Tapping 8. Reaming 9. Sawing

which the lubricant continuously feeds from the reservoir placed around the bearings and in the pockets of the retainer. In this case the characteristics of the grease itself determine the rate at which it is supplied to the frictional surfaces. The same type of bearing will also illustrate Item 3 (that is, maintaining the lubricant in a usable condition). For example, if the grease separated into its component parts of oil and soap and parts of soap were fed to the bearing, unsatisfactory lubrication would occur. However, the means of supplying the lubricant is generally a mechanical problem involving a choice between bath lubrication, spraying or dripping the lubricant to the surfaces, supplying it under pressure, or any of the other numerous means of lubrication.

Maintaining lubricants in a satisfactory condition and compatible with their surroundings is probably the most important aspect of industrial lubrication. A number of examples of the service requirements of industrial lubricants are listed on Chart 8. It will be noted from this chart that these requirements cover a wide range.

Ball bearing greases have been discussed previously and require no further comment except that modern practice in greasing bearings does not require that the machine be stopped. It is important, however, to avoid over-filling and the vent hole should always be open when a ball bearing is being lubricated.

Centrifugal pumps in fresh or salt water service require water-proof greases in their packing glands. Calcium or aluminum greases of the proper consistency are usually satisfactory, although calcium base greases are not always suitable if the operating temperatures are too high. Pumps handling hydrocarbons and other solvents require lubricants that will resist the solvent action of these materials. Similarly, for caustic and sulfuric acid service, the grease must not react with the material being pumped. These latter three conditions are such that conventional greases are not satisfactory and special lubricants are required. Oil and greases coming in contact with nitric acid have a special requirement of chemical interest. If these lubricants contain more than a fractional percentage of aromatic hydrocarbons, nitrated products are formed and explosive mixtures may result.

Lubricants for use in canneries and all other food handling equipment must be suitable for human

consumption, at least in small quantities. Some of the tests for cannery greases would be of interest. In one test, two drops of the lubricant are placed in a can of pineapple which is then cooked and sealed in the normal manner. If the lubricant may be detected by odor or taste in the finished product, it is unsatisfactory. Another test is made by adding five grams of grease to 200 c. c. of distilled water, from which 20 c. c of condensate are distilled. If this condensate has more than a very slight taste, the lubricant is unsatisfactory.

Dredger greases must be suitable for lubricating the moving parts when the frictional surfaces are exposed to muddy water. It is important also that these greases float on the water when they are used for gold dredging operations. If they sink and become mixed with the ore, their gummy nature may impede the separation of the gold.

The oils used for the lubrication of large steam turbines have certain rigid requirements. They must be of suitable viscosity and have high resistance to oxidation. This latter property is important, because as oils oxidize, their demulsibility or the rate at which suspended water will settle out, is decreased. In most turbines there is some leakage of water into the lubrication system, which will cause emulsions and the formation of a permanent froth if the centrifuges cannot remove it from the oils. Rusting in turbine oil systems is also an important problem and an ASTM committee has been formed to investigate and develop laboratory test procedures so that development work to improve turbine oils may be undertaken.

The oxidation inhibitors used in turbines and other lubricating oils have certain requirements. They must be soluble in oil under all conditions of storage and use, and must be able to prevent the oil from absorbing oxygen. It is thought that the prevention of oxygen absorption is attained by introducing compounds that break the chain reactions early in the cycle by being more reactive with oxygen than the oil molecules. The prevention of rusting is attained by introducing chemical compounds that preferentially absorb on the iron surfaces and thus prevent condensed water from forming rust. This effect can be accomplished by a number of compounds that add oiliness to lubricating oils, for example, fatty acids. However, these materials are not suitable for use in turbine oils because of their adverse influence on emulsibility and their corrosiveness to certain bearing metals. Prevention of rusting is also desirable with respect to oxidation of the oil, because the small particles of rust have a large surface with respect to the volume and exert a powerful catalytic effect on the oxidation of oil. It is evident, therefore, that the ideal turbine oil would contain materials to prevent both oxidation and rusting.

The so-called "ice machine" oils are used to lubricate the compressors in various types of refrigerating systems. In operation they are exposed to ammonia, sulfur dioxide, methyl chloride, and numerous other refrigerants. The ammonia compressors do not present a difficult problem. Reasonably high stability to oxidation in combination with the ability to release dissolved ammonia are the primary requirements. Methyl chloride is soluble in lubricating oil, and compressor oils used with this refrigerant often are diluted with as much as 20% methly chloride. This dilution reduces the viscosity of the oil, and necessitates the use of a much more viscous lubricant than would be used otherwise.

Liquid sulphur dioxide is one of the substances used extensively in the refinement of lubricating oils, and the lubricants used for equipment handling this material must be capable of resisting its solvent action. For this reason, oils of high refinement are required and in some installations, "white oils" are necessary. White oils, however, do not always give good service in reciprocating pumps. For example, a vacuum pump was put in service for handling mixtures of air, phenol vapor and water. White oil was chosen to lubricate the pump because it was considered to be impervious to further treatment by the phenol. At the end of one month of operation, the pump was almost worn out. Rusting was excessive and a large amount of abrasion occurred between the rings and the cylinder. In view of the obviously poor lubricating qualities of the white oil the lubricant for the pump was changed to a high quality steam cylinder oil, and the pump was again placed in operation. After several months it was examined and found to be in excellent condition.

The most serious problem in compressor oils is gumming. This is most pronounced in air compressor service and may become so serious that the exhaust lines from the compressor are filled with gummy, lubricating oil residues. This is most common in the small air-cooled compressors, but occurs also in larger units. For example, gum formation from the air compressor became so serious in a local glass factory that a number of molds were contaminated by the cooling air and production of finished glassware had to be stopped and the air lines cleaned. This problem has since been alleviated by the use of a more stable oil.

The increased shipbuilding activity on the Pacific Coast has caused more attention to be directed toward launching greases. These products consist of a wax-like base coat which is applied to the ways prior to the launching, and a slip coat which is placed on top of the base. The application of the base coat is made by first melting it and applying several successive layers. In this way it is built up to the thickness of ¼ in. to ½ in. The slip coat is a soft, water-resistant calcium grease which is applied over the base coat about ¼ in. thick. During the launching, the base coat acts like the Babbitt in a journal bearing and the slip coat lubricates the frictional surfaces consisting of the wooden sliding ways and the base coat. The development of a suitable slip coat is relatively easy, but it is more difficult to design a base coat that has the ability to adhere to the under water sections of the stationary ways, allow no stratification between the various layers and have adequate crushing strength to support the weight of the ship.

In summary, it may be stated that industrial lubrication problems cover a wide variety of conditions, and that each type of application tends to be unique. In every case a careful study of the operation conditions and the unusual features of that particular application most be made. From these data, it may be possible to select a commercial lubricant or, as often occurs, develop a special product for the needs involved.

Industrial lubrication is becoming more technical and more chemical in its nature. The manufacture of greases and oils is now controlled by carefully standardized physical and chemical tests, and the old-fashioned control by appearance and feel are obsolete. Developments in lubrication are made by inventing new treating methods, new soaps for greases and new chemical additives for lubricating oils. All of these methods are almost entirely chemical in their nature, and it follows that progress in industrial lubrication will depend on progress in the chemical aspects of that field.

Bacterial Deterioration of Cutting Oil Emulsions

By L. LIBERTHSON

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The biological background behind the phenomenon of bacterial deterioration of cutting oil emulsions is authoritatively treated, with a detailed account of one "case history" in which the trouble was apparently causeed by anaerobic bacteria and cured by aeration of the emulsion. The author also points out that the same basic phenomenon may bear upon the subject of corrosion protection.

Introduction

INDUSTRIAL chemists and lubricating engineers, familiar with the technology of cutting oils and the highly essential role which these compositions play in expediting production or armaments, have nevertheless wished, and not infrequently, that their use was not fraught with as many "nuisance" difficulties as have been experienced with one oil or another—difficulties which presented laboratories engaged in their development with some highly refractory problems.

Cutting oils may be roughly divided into two major categories:

1. Those which are used "straight" as, for example, sulfurized mineral, vegetable or animal oils.
2. Emulsifiable or so called "soluble oils."

The present paper deals directly with the latter type, although it will be seen to have at least an implicit bearing on the first type as well.

When speaking of emulsifiable oils, it is perhaps more pertinent to speak of emulsions since the state in which these oils are used is aqueous dispersion. This at once involves several qualitative functional considerations. From the standpoint of sheer usefulness, aside from the obvious function of the emulsions as coolants, a function inherent to any aqueous system, the one property of cutting oil emulsions on which perhaps the greatest emphasis is placed is stability. There are many external and environmental factors which are capable of affecting this property, sometimes so adversely as to render the emulsions useless. (It is assumed as a matter of course, that the internal factors governing stability have been adequately taken care of by the manufacturer of the soluble oil or soluble oil base itself.)

This paper, as will be seen from the title, deals with one external factor which possesses a degree of interest that, in the author's opinion, extends much further afield than is apparent in the case subsequently described.

Case History

Quite recently a prominent roller bearing manufacturing plant experienced considerable difficulties due to what appeared to be a persistent tendency of the cutting oil emulsions in use at the plant to lose stability and "break." The phenomenon furthermore was attended with such unpleasant manifestations as evolution of H_2S, with all its olfactory implications, progressive darkening of the originally white emulsion to dark muddy grey, and complete separation of the oil content in a black, evil smelling top layer which at the same time acted as a flotation medium for some of the solid debris dispersed in the emulsion. All of these effects were suspected to be caused by bacterial decomposition. That this suspision was well founded was confirmed by a recent patent[1] in the specifications of which, the following statement appeared:

> Oils are subject to bacterial deterioration depending on the kind of bacteria with which the oil has been contaminated. The glycerides may be split and the glycerine oxidized to water and CO_2 or the sulfur in the sulfate group may be reduced (sic!) to H_2S."

"Substantially anhydrous sulfonated fatty products . . . are not subject to bacterial action. This fact is of enormous importance when considering the difficulty with which germs in an oil are killed by bactericides and that oils decomposed by bacteria are no longer satisfactory for the purposes for which they are intended."

Since the cutting oil emulsions under discussion were obtained from soluble oils in which at least one of the active emulsifying agents was a sulfonated vegetable oil, the above quotations appeared entirely pertinent.

It was learned that the cutting oil emulsions which had deteriorated, were originally made up in central distribution unit batches for each of which a 25,000 gallon tank was used for storage. The practice at this plant had been to sterilize the stock emulsion by occasionally heating it to 160 F with live steam, a practice which, however, could not be continually adhered to owing to operating difficulties. By the time, which was several months later, that the emulsion began to deteriorate in the manner described, and before the true reason was suspected, nearly 100,000 gallons of emulsion had to be discarded. For a while the troubles were regarded as reflecting on the poor quality of the original bases from which the emulsions were made. Thus, the plant switched

from one source to another and after adopting material from the second source, a few months passed by when no difficulties were encountered. Then, however, and seemingly without warning, another stock of 25,000 gallons broke and had to be discarded. During this period production appeared to be at a peak and production schedules could not have been maintained, despite the knowledge that an abnormal decomposition process was taking place, unless fresh soluble oil was continually added to the emulsion to keep it from becoming totally useless. In addition, the practice of steaming the emulsion was restored.

That the trouble was essentially bacterial in origin was then confirmed by an actual count which disclosed that while immediately after steaming the emulsion, the bacterial count went down to a negligible level, upon cooling, the count reverted, after several hours, to several million per CC. Throughout this entire period, all mechanical conditions were checked as well as the sources of the mineral oil used; the hardness of the water and the pH variations were also considered without materially improving conditions. Then, a number of bactericidal agents were resorted to, despite which it was observed that eventually the stock emulsions darkened progressively with age and then developed the odor of H_2S and finally broke down completely.

Reviewing all these factors, the author was inclined to the theory that the causative agent was an anærobic type of a bacillus which utilized sulfur or sulfur compounds in its metabolism. It was then logical to inquire as to the origin or point of invasion of the bacilli. There was reasonable justification for the suspicion that the explanation could be found in the accumulation of debris found in the stock emulsion tank.

This debris was empirically analyzed and found to consist of metal fillings, powder, abrasives and such organic contaminants as tobacco juice, remnants of abandoned lunches and other putrifiable matter. Accordingly, it was decided to attempt to duplicate the deterioration in the laboratory and to make this possible, the author was supplied with samples of water, accumulated debris, mineral oil and also samples of the deteriorated emulsions.

Tests were then conducted in the presence and absence of air, wherein fresh emulsions were inoculated with spoiled emulsion, original cultures not being available due to the formidable difficulties in isolating the organisms from the deteriorated emulsion. Two striking observations follow: first, that deteriorated emulsions could be restored to fairly satisfactory degree of tability and nearly the original color, simply by air blowing. Where, however, no air was blown through and particularly where an oil seal was used to prevent air from being occluded in the emulsion, the deterioration was progressive to the point of copious evolution of H_2S.

The expedient of ærating emulsions appeared so simple that the above findings were transmitted to the plant, whereupon it was learned that blowing with air was precisely what the plant had adopted as a last resort. It was also attempted to insure stability by the use of small amounts of formaldehyde; this expedient, however, while adequate for the most part, would be open to the objection of the high volatility and diffusibility of formaldehyde, particularly in hot weather.

Thus, so far the only conclusion that could be drawn from the case was that somehow or other the particular scene of the difficulty contained environmental factors capable of sustaining the life of the bacterial organisms which were the positive agents. That these organisms were anærobic seemed to be an entirely valid supposition. Such organisms cannot multiply in an oxidizing atmosphere. Furthermore, the evolution of H_2S from the oil emulsions spelled out the presence of sulfur reducing bacteria capable of reducing both free and organically bound sulfur to sulfides. This suggested as a possible direct attack, the investigation of the vulnerability of various sulfonated compounds to such decomposition. However, such a recourse would, of course, involve the alteration of other functional properties of the resulting emulsions, a step which it was hardly possible even to consider in view of the manifold number of factors involved.

Bio-Chemical Background and Practical Implications

The provocative nature of the case above described, however, is such that the author was tempted to correlate the phenomenon with existing knowledge of sulfur bacteria and the biodynamic factors characterizing their metabolic processes.

There are two types of sulfur bacteria: one is capable of oxidizing sulfur and sulfates. One of the first pioneers in studying these sulfur fixing types, was Dr. Selman Waksman of the New Jersey Agricultural Station, New Brunswick, New Jersey (more recently in the forefront as the dsicoverer in the development of bacteriostatic organisms of the penicillin type such as streptomycin).

Among the individual species in the sulfur fixing class are, for example, thio-bacillus thio oxidans; thio-bacillus coproliticus; thio-bacillus thioparus; thio-bacillus novellus. A particularly wide spread genus is the so-called purple thio-bacillus which secretes a catalase activated by æration[2]. This bacillus plays a considerably useful role in the field of sewage treatment. Thio-bacillus thio-oxidans is described[3] by Vogler as an autotrophic organism requiring as a specific nutrient, sulfur or thio-sulfates and rather ambi-valent in its ability to take up sulfur even in the absence of oxygen. A fascinating aspect of the conditions under which this particular genus metabolizes sulfur lies in the fact that it stores sulfur by dissolving it in fat globules which it carries in terminal position in its cell. This fat is highly unsaturated, having an iodine value far in excess of that of any known natural fat.[4]

In England, sulfur bacteria have been discovered in peat, capable of removing H_2S from water gas and coal gas. The action of these bacteria is accelerated by the presence of ammonia in concentrations of about 0.5%[5].

The above references to the oxidizing type of sulfur bacilli are given for reasons other than merely illustrative or informative, for it will be seen from the following notes on sulfur reducing bacteria that an environment is conceivable wherein infection by one type might possibly be fought, for instance, by inoculation with the opposite type[13]. While entirely speculative, this may be an interesting direction of research which it is hoped some enterprising industrial bacteriologist will eventually pursue.

Kegel[6] observed that when manufactured gas is cooled by direct contact with water, the H_2S content is increased owing to the biological reduction of the sulfates in the water according to the reaction $CaSO_4 + 2\,CO_2 + 2\,H_2O = Ca\,(HCO_3)_2 + H_2S + 2\,0_2$. He found that the sulfate reducing bacteria will develop between 15 and 50C (with an optimum temperature of 25C) and that the bacteria can be destroyed by the addition of 0.3 to 0.5 grams of chlorine per cubic meter of water.

Again, there is an illuminating discussion in the Gas Journal[7] wherein it is stated that sulfur bacteria can develop H_2S in water sealed gas holders, often in a concentration in excess of accepted limits. The bacteria develop rapidly in the water in the absence of a suitable bactericide, as they require anærobic conditions and only relatively small concentrations of sulfate phosphate and other anions for their metabolism. A method for detecting the presence of these bacteria in water holders by incubation at 30C. in the presence of calcium carbonate is described. It was found that crude naphthalene killed bacilli in one holder in one test, but was ineffective in another. It was suspected that the toxic action was due rather to an impurity in the naphthalene.

Victor Czurda[8] reported that intensive reduction of sulfate to sulfide was obtained by crude bacterial cultures in simple media comprising ammonium chloride 0.1%, potassium acid phosphate 0.001%, ferric chloride 0.0001%, sodium sulfate 0.1%, sodium carbonate 0.2%. *An oxygen free gas phase containing* 13% *of* CO_2 *was found essential for the reduction.* There was abundant H_2S formation as indicated by copious precipitation of FeS and positive tests with lead acetate paper. Uninoculated media showed no reduction. More than 75% of the 493 milligrams of sulfate per liter of media was reduced. This sulfate reduction was regarded as extraordinary in that it occurred in the complete absence of detectable organic matter and hydrogen gas.

The presence of CO_2 was concluded as indispensable for the process.

This last reference is very significant for, if the presence of CO_2 is critical for the activity of the bacillus it is quite possible that at the plant discussed in our case history, the emulsion had not only acquired a CO_2 content through the decomposition of organic matter in the debris which accumulated but had also been secondarily infected by one or more of the familiar organisms[9] which utilize paraffin hydrocarbons to form CO_2 and water. It is also pertinent in this connection to recall[10] that at 28C on an exposed surface of 10 square centimeters, 7.5 milligrams of kerosene and 4.0 milligrams of paraffin deposited thereon as a film, were oxidized in ten hours, ultimately to CO_2 and water via an intermediate phase in which various fatty acids were formed. In the author's opinion, the symbiotic functioning of such hydrocarbon consuming organisms in the presence of sulphur reducing bacilli might conceivably be sufficient to supply an environment with the CO_2 necessary for the activity of the sulfur reducing organisms.

Czurda further showed that the organisms operating in his tests function best in the dark and that the presence of peptone accelerated the reducing action; also that other organic compounds, including acetates, tartrates, ethyl alcohol, citric acid were either ineffective or only negligibly inhibitive towards checking the reduction. Czurda isolated the organism in question. It appeared to be a colorless spirillum resembling spirilo vibrio desulfuricans. It was concluded that since organic hydrogen donors and hydrogen itself are excluded, this sulfate reduction represented a hitherto unknown biological process.

Finally, it has been reported in a recent article in the Journal of the Society of Chemical Industry (October, 1945) (not available at the time of writing) that sulfur producing bacteria can be inhibited by dye stuffs in the Flavine type. While this article is silent on the subject of soluble oil emulsion, it does indicate that advantage may be taken of the finding in preventing corrosion of underground cables, fouling of gas holder waters and fouling of wheat washing plants by bacteria producing H_2S.

Possible Implications Applying to Other Fields

The above disclosures lead into a field which has been brought into tremendous prominence during World War II, namely corrosion of metals. To speculate that sulfur bacilli play a role in this field is not necessarily a tangential departure from the main subject under discussion since emulsions or emulsifiable compositions containing organic sulfur compounds are used for corrosion inhibiting purposes and since the factors responsible for breaking emulsions under one set of conditions can very well operate under another set of conditions.

Thus, Pont[11] states that the presence of sulfate reducing bacteria, high concentrations of sulfur and low concentrations of sulfate in the neighborhood of corroded pipe in sub-soil service indicate that biological sulfate reduction produces the free oxygen which increases corrosion. It is also known[12] that microbiological corrosion of pipe lines due to sulfate reducing bacteria is strikingly prevalent in the Eastern United States and is characterized frequently by greater pit depths (on the corroded surfaces) than are common in such locations where corrosion is not present. It is shown that bacterial corrosion frequently exhibits a pronounced increase with time when sulfur bacteria are active and that iron sulfide is always found as a corrosion product. That this phase of the subject has received considerable study is indicated in a comprehensive review of the methods used for following the microbiological anærobic corrosion of pipe lines to be found in the Petroleum Engineer. Volume 11, p. 6-7, 1940. In view of the above, it does not seem to be far fetched to conclude that we are dealing with a phenomenon which can conceivably operate under conditions other than those which characterize the environment in which it manifested itself as a cutting oil emulsion breaker and deteriorant. The author feels that it is altogether within reason to attribute at least partly, to sulfur reducing bacilli, such manifestations as:

(a) Frequent failures of so-called rust inhibiting compounds and even paints to prevent corrosion of metallic surfaces.

(b) Failure of so-called preservative oils which were specified and used in vast quantities by the Army, Navy and Ordnance Divisions of our armed forces, to function consistently and uniformly in the manner intended for them.

In the light thrown by the foregoing upon this, it appears that if the bacilli under discussion reduce sulfates such as calcium sulfate, in the absence of air, the interface between the paint film which contains sulfates as a pigment component and a metal surface, represents an environment conceivably favorable to the activity of bacillus, particularly since the metal surface would be attacked as a result of the metabolic products of the bacillus probably as fast as they are generated. The author has seen many instances in which, for example, a rust inhibitive paint meeting all specifications is effective under one set of conditions and yet fails under a seemingly identical set of conditions, the failure manifesting itself *underneath* the film and attributable to no exterior agency.

In the case of "preservative oils" where, for instance, a given oil passes

specified corrosion tests in one environment and fails the presumably identical test in another, it would seem to be within the realm of possibility to those familiar with these oils that what we are dealing with is an environment in one case sterile in respect to sulfur reducing bacteria, and in another case, infected with these organisms. In cases such as the latter, from the standpoint of an environment favorable to the functioning of the bacillus, we have chemically organic combined sulfur in the form of at least two components, petroleum sulfonates and organic sulfur containing inhibitors; petroleum hydrocarbons in the form of the major vehicle; and, physically, a thin film and temperature conditions favorable to the metabolism of the bacillus, as exemplified by typical humidity cabinet testing conditions.

Combining all these factors in view of the disclosures of Czurda, Sohngen, to mention only two of the references, we may be dealing with environmental complexes which may very well upset the best intentions of the formulator or the research chemist, unless the conditions under which his products are tested and utilized are controlled to obviate the intrusion of the microorganisms under discussion. Since, however, such control in most cases is impractical if not impossible, and the technical approach cannot be "surgical," we must only resort to either the "prophylactic" or the "therapeutic." In other words, if the sulfur reducing bacilli are at the bottom of some of the troubles which harass the corrosion and lubricating oil engineer, and their intrusion cannot readily be prevented, and obviously the environment under which they operate cannot be destroyed, the logical recourse would seem to be either to render the environment hostile, that is, to render the bacilli incapable of functioning: or to arrange the storage and distribution of the emulsion so that these operations are conducted under absolutely sterile conditions, i.e., avoid infection from the start.

Thus in case of the ball bearing plant which brought these difficulties to the author's attention, it would seem that the organisms being anærobic, the introduction of air into the system renders the bacilli incapable of multiplying. Other forms in which the same idea could be conceivably used, since large volumes of air necessary for blowing large volumes of emulsion may present a recourse which is not always easy to adopt, would be the use of highly oxygenated or oxygen evolving compounds such as Sodium Perborate in amounts sufficient to produce the desired inhibiting effect. Specific bactericides are, of course, also conceivable, but this, however, is a problem for the biologist rather than the chemist.

Summary

In this paper we have attempted to provide a brief insight into the biological background behind the phenomenon of bacterial deterioration of cutting oil emulsions. Purely by way of speculative inference we have pointed to the possibility that the same basic mechanism may also play a role or at least be in part responsible for the difficulties experienced, in the field of corrosion of metallic equipment and machinery.

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REVIEWS OF CURRENT BOOKS

CATALYTIC CHEMISTRY—
By Henry William Lohse
Chemical Publishing Company, Inc. Brooklyn, New York—1945. 471 pages—Price, $8.50.

This book should be of general interest to every chemist, chemical engineer, and technical worker in any industry in which advantage is taken of the effects of catalytic phenomena. Relatively few industries are outside of this classification. "Catalytic Chemistry" will serve as an excellent text for the study of the theory of catalysis as well as an authoritative reference for the nature and properties of the various specific catalysts and their reactions.

The first two chapters of the book consist of, perhaps, a too-brief history of catalysis and a comprehensive presentation of catalytic theory. The latter chapter, covering 105 pages, should be understandable to the average engineer regardless of his chosen field. The author stresses the importance of the fact that in even our purest laboratory substances the contents of minor constituents are of an order of magnitude equal to what is considered significant in catalytic reactions; and, further, he draws on his long experience in spectroscopic analysis to discuss various minor constituents and their possible catalytic effects on chemical reactions.

Chapter III presents the properties of the chemical elements and many compounds in catalysis and includes a discussion of the effects of structure on catalytic activity. Chapter IV is a discussion of the various specific types of catalytic reactions, inorganic, organic, and enzymatic. The last chapter is a review of the important industrial catalytic reactions and contains analyses of processes found in the heavy chemical, the fine chemical, petroleum, and synthetic rubber industries.

The volume's clear illustrations and its extensive bibliography increases its value as an addition to a technical library.

WILLIAM H. ROBERTS, JR.
Northwestern University.

Development Opportunities For the Lubrication Engineer*

By C. S. BULLIONS

Chief Engineer, Pittsburgh District, Socony Vacuum Oil Co.

THIS subject was chosen after considerable discussion with your program committee. Undoubtedly, it has been considered amongst yourselves many times. Frankly, the Lubrication Engineer does not enjoy the recognition in industry that the Mechanical, Electrical, Civil, or Metallurgical Engineer has attained. Nor does this Association yet enjoy the rating of a Scientific Society. It is proposed to examine the ground, over which we have travelled, find out where we are, determine where we wish to go from here, and set a course which will get us "furthest fastest."

While the art of lubrication probably started before the invention of the wheel, when men skidded stones over fat-greased logs, yet the actual use of the term "Lubrication Engineer" is relatively new. It originated with a major oil company. The marketing of lubricants for use in machines of increasing capacities demanded practical knowledge of such equipment. To provide men with such fundamental appreciation of industry's problems, this company brought into its organization many who had been Master Mechanics in various plants. These men were given the title of "Lubrication Engineers."

Their function was to educate the buyer of lubricants in their correct application, to keep the refinery advised of the need for new and better products, to test these products in the field, and to help the customer to help himself. All oil companies have adopted this service today, and it has been developed into an important function of the lubricant supplier. The manufacturer of lubricating systems and devices has also provided valuable technical service to industry.

Many present-day devices were the result of combined thinking on the part of these "Lubrication Engineers," and men in the plants. A tinsmith was called upon to produce a number of constant-level, wick-feed oilers. His enthusiasm for the work, and the results obtained, brought him to the attention of the management and a new position was developed, "Lubrication Foreman." Later, this title was changed to "Lubrication Engineer." Many of our "Lubrication Engineers" have reached that position in a similar manner.

Every type of engineering has developed in such a manner. The first Civil Engineers in this country had no college degrees in engineering. Their function was to improve the farms, and study the topography of the country. They were named Civil Engineers to differentiate them from Military Engineers. They developed a science which could be set forth in text-books and studied in a college. A rich man in New York State provided the funds to bring together certain outstanding Civil Engineers and educate young men for the degree of Civil Engineering. Their engineering is sometimes called Static Engineering — engineering of the pioneer. Lubrication should be classed with Mechanical and Electrical as one of dynamic engineering.

Other wealthy men, and the industries, have provided funds for the development of the various branches of engineering. But there are few, or no, fellowships in our colleges for the development of the science of lubrication. We continue to work by experience or rule of thumb. There is no true science in our application of lubricants. There are no mathematical formulas which can be applied accurately by such problems. There are few curves representing the results of studious tests in actual use. The most important single item in the operation of industry has been given the least scientific study.

We want to change that condition. We want the Lubrication Engineer to have a status equal to that of any other engineer. We want his pay check to reflect that status. We can do it by proving to industry that our function is important, that our knowledge is important, and that effective use of that knowledge means increased production, decreased maintenance, less lost time, and greater profits.

To accomplish this end, we must pull together. There are three groups represented here, who should work together to improve the position of the Lubrication Engineer, and to develop the science of Lubrication Engineering. These groups comprise the men responsible for plant lubrication in Industry, the men who sell lubricating devices, and the men who sell lubricants.

Speaking for the men who sell lubricants, there is no question about their desire and willingness to help customers secure the benefits of correct lubrication. The research facilities of the oil companies, our technical staffs and district representatives, have been, and remain, ready to cooperate towards that end. The oil industry is alive to the development of any improved testing devices which will enable you to judge lubricating products on performance rather than physical characteristics.

The first step, however, is to sit down together, plan a course of self-education, determine what facilities are available for research within our present reach, and possibly to supplement these with Fellowships at the Colleges. These should be maintained by Industry. Industry should welcome such a program. It will mean a great saving in money and effort if properly organized and conducted. It is not unusual for a large organization to discover that several of its plants have been conducting tests for identical purposes. Large oil companies often find that several of their branches have been conducting identical tests without the knowledge of headquarters. This is wasteful and should not occur. There is need for greater correlation of our scientific efforts. This can be corrected by closer relations between Supplier and Consumer—between the oil company engineer and the industry's Lubrication Engineer.

These are probably the very foundations upon which this Association was founded. There is evidence that you are feeling your way toward solid ground, from which you can take a good running start. It is essential that there be a mutual understanding of all factors involved in the manufacture, sale, and use of lubricants. We want to go on trying to develop the best possible lubricants, and to help you to use them most effectively.

* *This paper was presented before the Pittsburgh Section of the American Society of Lubricating Engineers October 19, 1945.*

Limitations of Greases For Anti-Friction Bearings

By HUDSON T. MORTON

Chief Metallurgist, Hoover Ball and Bearing Co., Ann Arbor, Mich.

THE ideal lubrication for anti-friction bearings would be obtained when a few drops of oil are added to the bearings at regular intervals and the excess allowed to drain into a sump for filtration and re-use. An important difficulty associated with the use of oil lubrication in such an application is that of the development of adequate seals which would be needed in order to prevent the oil from leaking into the other parts of the motor and other associated mechanisms where the presence of an oil would be deleterious. Seals which are effective in preventing oil leakage have the disadvantage of increasing the friction and power consumption.

To overcome the leakage and sealing problems, greases have been developed for use in anti-friction bearings. Various combinations of oils and soaps have been tried in an attempt to maintain a sponge for the oil and allow the proper amount of oil to ooze out of the soap to wet the ball or roller contact surfaces. At the same time, it is hoped that none of the grease will leak out of the ordinary seals in the housing. In addition to the fact that leakage of grease from the bearings can be controlled more easily than would be the case if oil were being used, there are certain other advantages associated with the use of grease. One of these is that when the anticipated anti-friction bearing loads are light, the grease can be placed in the bearings at the time of manufacture. This decreases the danger of infiltration of dirt into the lubricant and bearing. Seals or shields on the bearings are also more effective and eliminate or decrease the need for expensive sealing devices in the housings. A disadvantage to pre-lubricated bearings, in many cases, is that these must be used while the grease is still relatively new for if the bearing is packed with grease and then allowed to stand idle for long periods of time before use, the danger of the grease drying out, becoming hard, oxidizing, etc., is greatly increased.

Anti-friction bearings are being used in applications which vary in temperature from —70F to 300F. Thur far, no one grease has been found which can be used for this wide temperature range. As a result, the bearing industry has had to use three or more types of greases; namely, low temperature greases, normal temperature grease, and high temperature grease.

To further complicate the problem, bearing users are continually designing their equipment to operate at higher speeds. We have numerous applications of small anti-friction bearings operating above 10,000 rpm with grease lubrication. Occasionally an application may operate as high as 15,000 to 20,000 rpm with grease lubrication, but these applications are not frequent and generally require special bearing design along with a special lubricant. For the purpose of this discussion all remarks will apply to speeds below 10,000 rpm or those having a speed-factor (bearing bore in millimeters x rpm of shaft) of less than 150,000.

This article includes brief descriptions of the tests in common use to determine the characteristics and probable operating behavior of greases as applied to anti-friction bearings, and also lists some further tests which are now under consideration by the National Lubricating Grease Institute and Committee "G" of the American Society for Testing Materials.

About ten years ago the bearing manufacturers realized the shortcomings of greases for use in anti-friction bearings. They then set up a two-fold program of cooperative tests of greases. First, they attempted to simulate actual service conditions in an attempt to find satisfactory greases. Secondly, they tried to set up laboratory equipment and test procedures by which they could evaluate each batch of grease for comparison with previous batches, and prevent the use of inferior greases.

Two pieces of equipment were developed and are being used extensively for these purposes. The ABEC (Annular Bearing Engineers' Committee) torque test machine measures the torque of grease in a number 204 annular ball bearing. Readings of torque are taken at one minute intervals for 20 minutes during rotation and give an indication of torque in actual operation. Bearing temperatures are also recorded. This machine can thus separate greases into three groups, soft non-channeling with low torque, stiff non-channeling with high

torque, and channeling grease with low or intermediate torque. Most greases rise in temperature after a few minutes operation, but reach a constant temperature in 2 to 10 hours of operation but rise again suddenly when their life is expended.

The Norma-Hoffman Bomb measures the oxidation of grease when subject to 110 psi oxygen pressure at elevated temperature. This test procedure has been correlated with storage life so that definite limits in the laboratory test correspond to 18 months, 24 months, etc., on the shelf.

Recently, the National Lubricating Grease Institute (NLGI) and Committee "G" of A. S. T. M. have been cooperating with ABEC in a series of grease testing programs. It is expected that more laboratory equipment and test procedures will be agreed upon so that they can be incorporated in existing specifications for use of all who require greases. Bleeding tests, evaporation, and leakage tests are some of those under consideration.

Three types of greases are being used extensively in anti-friction bearings. The government agencies have written specifications covering each of them, as follows:

AN-G-3a for low temperatures
3560E; 2-108; 14L3 for normal temperatures
AN-G-5a for high temperatures.

The AN-G-3a greases generally consist of a lithium soap mixed with a light oil. They work well at low temperatures but should not be used in applications where high temperatures are encountered.

The normal temperature grease has a soft consistency, is non-channeling and has very good lubrication properties in anti-friction bearings. It has disadvantages at high speeds where the grease is churned sufficiently to cause excessive leakage through the seals or shields of the bearing or housing. It is especially advantageous where the speed factor does not exceed 75,000. In many cases it can be used at temperatures up to 200F. Adequate seals should be provided with each bearing application.

The AN-G-5a greases are new on the market but tests indicate that they should give satisfactory service in anti-friction bearings where the temperature might be as high as 300F. More service data on these greases are being accumulated daily.

For re-lubrication purposes the non-channeling greases have given most consistent results. They have a worked penetration in excess of 260 so that they can be used in a grease gun and forced thru ordinary greasing equipment. They have sufficient oil to wet all bearing surfaces and prevent friction. Their use presents a distinct problem of leakage. High speeds will throw them out of the ball or roller path and cause the bearing to run dry. Normal churning of the lubricant causes internal friction and a rise in bearing temperature with resultant expansion and leakage.

Summing up these remarks, it appears that a universal anti-friction bearing lubricant has not been developed. In the meantime, three general types of greases are in use, and there is still definite need and room for improvement in many of their operating and physico-chemical characteristics.

Directors Now Elected!

A COMMITTEE consisting of E. J. Ehret, Chairman, John D. Kinsey and A. L. Weller, was asked by the Secretary of the Society to act as Tellers of the mailed ballots for Society Directors.

The committee reports that of the 176 ballots received through the mail, 135 voted for the whole list, 37 were split, and the remainder suggested a scattering of other candidates. It is thus our pleasure to announce that the new group of Directors has been officially elected to serve, and each took office the first of December.

Complete biographies of these men were given in the October issue of LUBRICATION ENGINEERING but, for convenience, we are relisting their names:

C. A. Bierlein
W. T. Everitt
E. F. Graves
C. M. Larson
G. Radosevich
G. L. Sumner

The Society looks forward to continued progress under their guidance and leadership. One of the first duties of the new Directors will be the election of Officers for the coming year. A Directors' meeting is being planned for January 7 in Chicago at which time the new Officers will be named and plans for the Spring Convention will be culminated.

Necrology

THE Society was grieved to hear of the passing of two of its loyal members.

"WILLIAM DANE HOOPER, Industrial Engineer at the Chicago office of the Sun Oil Company, died of a heart attack at his home in Beverly Hills on December 1st. 'Dane,' as he was affectionately known, entered the employ of the Sun Oil Company in February, 1919, and during his twenty-seven years of service with the Company endeared himself to all who came in contact with him. A long list of manufacturers in the Chicago area came to rely upon his advice in all matters concerning industrial lubrication. He will be sorely missed by all who knew him. He is survived by Mrs. Hooper, three daughters and two sons."

"DR. ALAN E. FLOWERS, for the last twenty years head of the Research and Development Department of the DeLaval Separator Company, passed away December 10th. Dr. Flowers was born in 1876 and had a varied career. He was with the Westinghouse Electric and Manufacturing Company, a Professor at the University of Missouri, a Captain during the First World War, and an inventor of note. Dr. Flowers is survived by Mrs. Flowers, a son, George S. Flowers of Hartford, Connecticut, and a daughter, Miss Nancy Holmes Flowers, of Poughkeepsie, New York."

OILS AND LUBRICANTS PATENT ABSTRACTS

Lubricant—Patent #2,384,002—Alfred L. Bayes, assignor to Carbide and Carbon Chemicals Corp. A lubricant comprising a mineral oil containing corrosion and oxidation inhibiting amounts of an additive mixture composed of mercaptobenzothiazole and a dimorpholine sulfide.

Lubricant—Patent #2,384,023—Lionel S. Galstaun, assignor to Tide Water Associated Oil Co. A lubricating composition adapted for use in the lubrication of surfaces exposed to mixtures of hydrogen halides and hydrocarbons which comprises a major portion of substantially anhydrous lanolin and a minor portion of graphite.

Method Of And Means For Desalting Petroleum Well Fluids—Patent #2,384,222—Jay P. Walker, assignor of 40% to Guy O. Marchant and 6% to C. G. Wells, both of Tulsa, Okla. The method of continuously treating and removing extraneous matter from well fluids in the field as they flow from the well which includes, separating the free water from the well stream, whereby the water content of the well stream is reduced, then conducting the stream into a confined body of heated water wherein said stream is heated and treated to break emulsions and to further extract water from the emulsified oil, admixing fresh water with the well stream and the body of heated water, flowing the mixture upwardly through a body of salt water, whereby extraneous matter held in suspension in the well fluids is agglomerated with the fresh water in said body of water, and precipitating the extraneous matter from the flowing fluids.

Oil Cooling Device—Patent #2,384,248—George Herbert Gill, assignor to The Garrett Corp., Airesearch Manufacturing Company Division. In an oil cooling system for an internal combustion engine, the combination of: an oil cooler through which the oil may be circulated in heat exchange relation to a cooling fluid passed therethrough; means for varying the rate of flow of said cooling fluid through the cooler; a thermostat responsive to oil temperature at a selected point in the system; means controlled by movement of the live end of said thermostat for operating said flow varying means; and means for normally holding the other end of said thermostat in a fixed position, said last means including means responsive to a pressure drop across the cooler in a predetermined amount for moving said other end of the thermostat and thereby moving the thermostat so as to override the thermo-responsive action thereof and operate said flow varying means so as to reduce the cooling capacity of the cooler.

Process For Cracking Crude Hydrocarbon Oil—Patent #2,384,315—Paul E. Kuhl, assignor to Standard Oil Development Co. In a process for cracking crude hydrocarbon oils in the presence of an active catalyst wherein the oil contains objectionable nitrogenous base impurities which affect the yield and character of the products obtained by the catalytic cracking step; the method of reducing objectionable nitrogenous impurities contained in said oil which comprises passing said oil through a mass of an adsorptive material consisting principally of aluminum oxide.

Cracking of Hydrocarbon Oils—Patent #2,384,356—Charles W. Tyson, assignor to Standard Oil Development Co. A method for catalytically cracking hydrocarbon oils to form lower-boiling products suitable for motor fuels which comprises vaporizing the oil to be cracked, injecting a powdered catalyst into a stream of said hydrocarbon vapors, passing said stream containing said powdered catalyst through a reaction zone maintained at reaction temperature, maintaining said vapors within said reaction zone at a velocity sufficient to maintain the catalyst in suspension, keeping the catalyst and vapors in said reaction zone for a period sufficient to effect the desired cracking thereof, thereafter separating the powdered catalyst contaminated with volatile residual oil products and carbonaceous deposits from the cracked vapors while at a temperature sufficient to avoid any substantial condensation of said cracked vapors, thereafter fractionating the cracked products to separate the desired motor fuel products therefrom, removing volatile residual oil from the catalyst so removed, thereafter suspending the catalyst so removed in a gaseous stream, passing said stream containing said powdered catalyst through a regenerating zone, mainaining an oxidizing atmosphere within the regenerating zone at a temperature sufficient to burn carbonaceous deposits contained on said catalyst, introducing a cooling fluid in direct contact with the catalyst within said regenerating zone to control the temperature of regeneration below a predetermined maximum, thereafter separating the regenerated catalyst from said gaseous stream and returning the same to said first mentioned reaction zone.

Method of Treating Vulcanized Oils—Patent #2,384,491—Karl Werner Posnansky, assignor to The Stamford Rubber Supply Co. In the manufacture of vulcanized oil products from fatty oils, the steps of which comprise first mixing said fatty oil with sulphur and heating until the desired degree of vulcanization is obtained, and then treating the vulcanized fatty oil substantially at room temperature with ammonia, until the hardness of the vulcanized oil is substantially increased.

ABSTRACTS OF PATENTS OF INTEREST TO LUBRICATION ENGINEERS WILL BE A REGULAR FEATURE OF THIS PUBLICATION FROM NOW ON.

The abstracts in this issue are from the Official Gazette — Vol. 578, Nos. 1, 2, 3, 4; Vol. 579, Nos. 1, 2, 3, 4, 5 and cover the period from September 4, 1945 to October 30, 1945, inclusive.

Printed copies of patents are available from the Patent Office at 10 cents each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

Lubricant—Patent #2,384,551—Leon P. Jehle, assignor to Carbide and Carbon Chemicals Corp. A lubricant consisting essentially of mineral oil containing a detergent composed of about 0.20% to 5.0% by weight of a metal salt of an acid of the group consisting of 2-ethyl butyric acid and 2-ethyl hexoic acid.

Lubricating System for Machine Tools—Patent #2,384,590—William C. Baldenhofer, assignor to The Thompson Grinder Co. A lubricating system comprising: means for delivering lubricant at desired points in open circuit; flow controlling and pressure establishing means in the delivery line of said lubricant delivery means, said flow controlling and pressure establishing means being connected intermediate said delivery means and said desired points; switch means adapted to be actuated by pressure established by said pressure establishing means in said delivery means and connected thereto; and fluid handling means actuated by said switch adapted to control the movement of operative elements; whereby lubricant pressure and flow are established at desired points before said operative elements are placed in motion.

Lubricating Oil — Patent #2,384,595 — Charles M. Blair, assignor to Petrolite Corporation, Ltd. A lubricating oil, consisting of a mineral lubricating oil and a relatively small amount of an ester; the amount of said ester being within the approximate range of 0.25% to 5%, by weight, based on the weight of the aforementioned mineral lubricating oil, and said ester being an alpha-beta unsaturated carboxylic acid-unsaturated aliphatic alcohol polyester addition-condensation polymer said acid containing less than 10 carbon atoms and being free from vinyl radicals and said alcohol containing at least 8 and less than 32 carbon atoms, and having at least 3 intervening carbon atoms between the carbon atoms to which the hydroxyl group is attached and the nearest ethylenic carbon atom.

Lubricating Device—Patent #2,384,824—George R. Eitner. In a grease gun having a supply receptacle, a body attached to the supply receptacle and having a cylinder therein and an enlarged chamber at one end of said cylinder with a valve seat formed between said cylinder and said chamber, a ball valve in said chamber, said ball valve having a larger diameter than said cylinder and adapted to engage said valve seat to close communication between said cylinder and said chamber, a coil spring in said chamber normally urging said ball valve into seating engagement with said valve seat, said body having an exhaust port from said chamber arranged to provide unrestricted communication with said cylinder through said chamber when said ball valve is unseated, said body also having an intake port establishing communication between said cylinder and said supply receptacle, and a piston reciprocable in said cylinder.

Method of Producing White Oils—Patent #2,384,905—Clyde M. Floyd and Julius Fram, assignors to Standard Oil Development Company. A method for producing white oils comprising the steps of subjecting a predominantly paraffinic petroleum stock to successive treatments with sulfuric acid, separating acid sludge from the oil and washing the oil with water after each acid treatment, and finishing the acid treated oil by drying and contacting with clay at temperatures substantially above atmospheric.

Cracking of Hydrocarbon Oils—Patent #2,385,216—Joseph V. Marancik and Homer Z. Martin, assignors to Standard Oil Development Company. A process for the conversion of hydrocarbon oil, which comprises heating a flowing stream of said oil, having dispersed therein finely divided catalyst particles, to a cracking temperature, introducing the resulting heated oil and dispersed catalyst as a continuous stream to one end of an elongated reaction zone and therein effecting cracking of the oil, withdrawing a continuous stream of conversion products and catalyst from the opposite end of said reaction zone, returning a portion of the last named stream to the reaction zone along with the heated oil, and separating cracked vapors and catalyst containing residue from the remaining portion.

Emulsion Deoiling — Patent #2,385,236 — August Henry Schutte. The method of producing an emulsion of a wax-oil mixture with water, which comprises adding to said mixture, in a liquid phase of the materials thereof, the water at a lower temperature than the melting point of the wax only and in materially excess quantity thereto, for chilling and solidification of the wax by water under moderately low temperature with relation to the melting point of the wax, passing said materials and the added water through an emulsifying zone for partial emulsification thereof, passing the partial emulsion so obtained to a settling zone and therein separating the partial emulsion from the excess water by settling of the latter, removing the partial emulsion from said settling zone, and recycling the so-removed partial emulsion through the emulsifying zone.

Car Journal Lubricating Device—Patent #2,385,280—Clarence L. Howard. A lubricating device for a railroad car journal, which comprises in combination three perforated trough-shaped sections in abutting relationship and pivotally connected at abutting edges, each said section being supplied with an outwardly extending lip along each side; for each said section an absorbent pad lying therein and extending over the upper part of said lips and having capillary feeders integrally formed therewith and depending through perforations in said section, each said section being substantially semi-cylindrical so as to extend over substantially all of the corresponding underside of the car journal when in use and so that said lips meet the lower edge of the journal bearing; tension springs joining abutting sections; rigid supports pivotally attached to each end section and extending downwardly and outwardly; flexible coupling means joining each end section and the corresponding rigid support, and a tension spring joining said rigid supports.

Recovery of Oil from Oil Fields—Patent #2,385,298—Morris Muskat, assignor to Gulf Research and Development Co. In a well extending through a gas-containing formation into a lower, oil-bearing stratum, a fluid conduit extending into the well and communicating therewith at a point near the bottom within the horizons of the oil-bearing stratum, and an elongated tubular choke made of a permeable medium enclosing the lower end of said fluid conduit and extending upwardly therefrom over the exposed face of said oil-bearing stratum and therebeyond at least to the plane of gas-oil contact.

Lubricating Device for Sewing Machines—Patent #2,385,299—Frank Parry, assignor to The Singer Manufacturing Company. In a sewing machine having a frame including a work-supporting arm free at one end thereof, said arm having a wall provided with a lubricant-supply reservoir, a shaft rotatably journaled in said arm and longitudinally provided with a bore, a loop-taker carried by one end of said shaft and having a thread-carrier raceway, said bore having lubricant-conducting connections with said raceway, separable lubricant-conducting wicks including a shiftable connection--wick, between said reservoir and the bore of said shaft, and manually operable means including an arm accessible exteriorly of said work-supporting arm for shifting said connection-wick out of and into effective lubricant-conducting position.

Catalytic Cracking of Petroleum Oils — Patent #2,385,325—William A. Bailey, Jr., assignor to Shell Development Company. In the production of useful products including gasoline and fuel oil from petroleum, the process comprising separating petroleum by distillation into a gasoline fraction, a light naphtha fraction, a heavy reflux condensate, and a reduced crude, subjecting the reduced crude to a flash distillation under vacuum to produce a heavy flashed distillate and a

heavy flashed residue, subjecting said heavy flashed distillate together with said light naphtha to catalytic cracking, separating the cracked product into a gasoline fraction and a heavier aromatic condensate and combining said heavier aromatic condensate with said heavy flashed residue to produce fuel oil.

Catalytic Treatment of Hydrocarbon Oils—Patent #2,385,326—William A. Bailey, Jr., assignor to Shell Development Company. A process for the catalytic conversion of hydrocarbon oils heavier than gasoline into useful normally liquid and normally gaseous products including gasoline, beta butylene and an isobutane-olefin mixture suitable for production of quality alkylate, which comprises the process steps of catalytically cracking the hydrocarbon oil in a fluid catalyst system with a finely divided cracking catalyst under conditions of temperature and space velocity to convert at east 10% of the hydrocarbon oil into normally gaseous products including propylene, butylenes and isobutane, selectively polymerizing propylene from said gaseous products predominantly to C_6 polymers, catalytically cracking said C_6 polymers simultaneously with said hydrocarbon oil at a higher space velocity thereby to produce additional quantities of isobutane and butylenes.

Process For Refining of Hydrocarbon Oil with Metallic Sodium—Patent #2,385,431—Richard S. Vose, assignor to Sun Oil Company. The process of refining liquid hydrocarbon material which comprises subjecting liquid hydrocarbon charge to the action of finely dispersed metallic sodium in amount substantially in excess of the amount chemically consumed in the reaction and at a temperature above the melting point of sodium but below the cracking temperature of the charge, until undesirable constituents of the charge are transformed into a sludge substantially solid at normal temperature, thereby resulting in a reaction mixture comprising refined hydrocarbon material containing sludge and excess sodium in dispersed form, passing said reaction mixture through a separation zone containing a magnetized surface and therein bringing the mixture into contact with said surface and maintaining said surface magnetized sufficiently highly to cause contained sodium particles to be attracted by and retained on said surface, withdrawing the mixture of refined hydrocarbon material and sludge from said separation zone, and then separating refined hydrocarbon material from the sludge.

Oil Container—Patent #2,385,532—La Verne E. Cheyney and Harold Judson Osterhof, assignors to Wingfoot Corporation. A bag containing lubricating oil, the walls of which are composed of a film of rubber hydrochloride of high impact strength which is plasticized with about 30 per cent diethoxyethoxyethyl succinate.

Lubricating Oil Composition—Patent #2,385,697—Marcellus T. Fiaxman, assignor to Union Oil Company of Calif. A lubricating oil comprising a blend of a major proportion of distillation bottoms obtained by reacting an olefin with an isoparaffin in the presence of an alkylation catalyst and distilling the reaction product to produce said distillation bottoms, said distillation bottoms having a Saybolt Universal viscosity at 100F of approximately 32 to 75 seconds, a viscosity index of less than zero and having substantially no lubricating qualities, within the order of from 0.01% to 0.1% by weight of naphthenic acids having an acid number in the order of from 140 to 150 and with from approximately 2% to 5% by weight of a butylene polymer having a molecular weight in the order of from 10,000 to 100,000, said lubricating oil having a substantially higher viscosity and viscosity index than said distillation bottoms.

Sulphurized Glyceryl Esters of Tall Oil and Method For Making Same—Patent #2,385,912—Gifford D. Davis and Edwin J. Barth, assignors to National Oil Products Company. As a new composition of matter, sulphurized glyceryl esters of tall oil.

Lubricant—Patent #2,385,964—Daniel E. Bergen, assignor to Phillips Petroleum Company. An improved lubricating oil composition comprising a mineral lubricating oil having incorporated therein a small quantity of bi-di-iso-amyl thiol thiono carbamate sufficient to increase the stability of the so treated lubricating oil against oxidation and sludge formation at crank case temperatures.

Process for Breaking Petroleum Emulsions — Patent #2,385,969—Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifier comprising the non-volatile resultant of an esterification reaction between (A) a monocarboxy acid ester; in said ester, the acyl radical RCO of the monocarboxy acid RCOOH is that of a detergent-forming acid having at least 8 and not more than 32 carbon atoms and is the substituent for at least one alcoholic hydroxyl hydrogen atom of an alcohol, which alcohol is in turn a hydroxylated amino ester.

Process for Breaking Petroleum Emulsions — Patent #2,385,970—Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp. A process for breaking petroleum emulsions of the water-in-oil type, which consists in subjecting the emulsion to the action of a demulsifier, comprising a sub-resinous member of the class consisting of acidylated esters of an acylated polyglycol ether and acylated esters of acidylated polyglycol ethers; said ester containing (a) at least 1 polycarboxy acid radical; (b) at least one high molal detergent-forming monocarboxy acid radical having at least 8 and not over 32 carbon atoms; and (c) at least one member of the class consisting of oxyalkylated polyhydric phenolic radicals and di (polyalkylene glycoxy) alkanes, in with the centra divalent aliphatic radical in turn is selected from the group consisting of the aliphatic divalent alkylene radicals containing from 8 to 18 carbon atoms and the di-cyclohexenyl dialkyl methanes in which each alkyl radical contains less than 3 carbon atoms, and each polyalkylene glycoxy chain contains from 5 to 20 alky.ene glycol radicals; said ester having at least one free carboxyl radical.

Method for Secondary Recovery of Oil — Patent #2,386,036—Roy Cross. That improvement in methods of increasing the recovery of heavy, viscous crude petroleum from subterranean deposits thereof, which includes the following steps: (1) extracting petroleum from the subterranean deposit, (2) heating at least a portion of the extracted petroeum to a temperature of 650F. or above in order to obtain a lighter fraction therefrom, (3) thereafter re-introducing into the deposit at least a part of the lighter fraction thus obtained, and (4) causing said fraction to penetrate to a considerable distance within the deposit in order to decrease the viscosity of the residual heavy petroleum within the deposit and to facilitate the further recovery of such petroleum therefrom.

Journal Lubricating Device—Patent #2,386,121—Edward C. Jeffers and Martin C. Jeffers. A lubricating device for a journal extending through an end wall of and into a journal box having a well below the journal for holding a lubricant, comprising a sheet of porous fibrous material having a base segment for location in the well and an upwardly extending segment for pressing against the journal and being disposed at an acute angle to the base segment, a pressure plate connected to said pressing segment, a resilient member connected to said pressure plate, and reacting against said base segment to press said pressing segment against the journal.

Lubricant—Patent #2,386,222—Bert H. Lincoln and Gordon D. Byrkit, assignors to Continental Oil Co. A lubricant comprising in combination a major proportion of oil of lubricating viscosity and a minor proportion of the reaction product of a phosphorous polysulphide and tri-isobutylene, said reaction product having a negative A.S.T.M. copper strip test when run for at least 30 minutes at 210F.

Phosphated Blown Oils—Patent 2,386,250—James G. McNally and Joseph B. Dickey, assignors to Eastman Kodak Co. The process of producing a modified oil which comprises blowing an unsaturated organic compound selected from the group consisting of the semi-drying oils, fats and waxes at a moderately elevated temperature and thereafter treating the blown compound with an acid of phosphorus, whereby a phosphato or phosphito group is attached to carbon through a carbon-oxygen-phosphorous linkage.

Production of Emulsions or Compositions of or Containing Organic Polysulphides and Articles Produced Therefrom—Patent #2,386,287 — John Rodriguez Blanco, Wylde Green, Sutton Coldfield, Albert Edward Toney Neale, and Douglas Frank Twiss, assignors to Dunlop Rubber Co., Ltd. A process for preparing improved emulsions of or containing organic polysulphides which comprises completely mixing an aqueous solution of an inorganic polysulphide with an aqueous emulsion of an aliphatic organic dihalogen compound and obtaining the reaction product in the form of a flocculate.

Lubricants—Patent #2,386,553—William P. Hilliker, assignor to Standard Oil Company. A lubricant comprising between about 5 and about 50% of a soda soap, between about 1 and about 15% of a lead soap, an organic halogen compound having a low vapor pressure and being resistant to thermal decomposition and hydrolysis at temperatures in the range of about 250 to 400F. and pressures above about 20,000 pounds per square inch, said halogen compound being present in quantity sufficient to furnish between about 0.1 and about 5% of halogen, between about 2 and about 15% of a sulfurized ester.

Treatment of Oil Wells—Patent #2,386,605—Erskine E. Harton, Jr. and Priscilla Lyon, assignors to The Pure Oil Company. The method of disintegrating calcium sulfate deposits at the bottom of earth bores which comprises contacting said deposits with concentrated aqueous potassium hydroxide solution containing at least 20% by weight of potassium hydroxide.

Cutting Oils—Patent #2,386,952—Everett C. Hughes, assignor to The Standard Oil Company. A process of making a cutting oil, which comprises reacting phosphorus pentasulphide with a mineral oil at 200-450F. for at least about an hour, then incorporating a long chain fatty acid ester to clear up residual phosphorus pentasulphide and subjecting to reaction temperature.

Emulsified Petroleum Products—Patent #2,387,157—Robert M. Kippenhoefer, assignor to Socony-Vacuum Oil Co., Inc. A composition of matter capable of ready dispersion in water to form a stable aqueous emulsion comprising from about sixty percent to eighty-six percent by weight of a material selected from the group consisting of petroleum oils and petroleum waxes, from about seven percent by weight to about twenty percent by weight of lecithin and from about seven perecent to about twenty percent by weight of an ester derived from mannitan and a high molecular weight fatty acid, the lecithin and ester being present in proportions ranging from substantial equality to not over eight parts ester to five parts lecithin.

Low Temperature Lubricants—Patent #2,387,170—John D. Morgan, assignor to Cities Service Oil Co. A low temperature lubricant consisting essentially of a polyhydronaphthalene having dissolved therein a small proportion of an extreme pressure agent sufficient to impart extreme pressure properties to the lubricant.

Process of Refining Crude Petrolatum—Patent #2,387,171—John D. Morgan and Angus R. Blakey, assignors to Cities Service Oil Co. A process for refining crude petrolatum to produce a series of separate fractions therefrom, which comprises the steps of diluting such crude petrolatum with a non-polar hydrocarbon solvent, passing the solution into a column of absorption material to separate it into fractions of different color, the dilution of the petrolatum preferably being such that not more than 5 percent of the diluted material will pass through the column as pure white petrolatum, thereafter extracting the petrolatum by passing additional quantities of said non-polar solvent through the column, separately collecting portions of petrolatum solvent solutions leaving the column in accordance with the color thereof, and separating said solvent from such separate portions.

Catalytic Polymers from High Boiling Unsaturated Products of Petroleum Pyrolysis—Patent #2,387,237—Waldo C. Ault, assignor to the United Gas Improvement Company. A process for producing a hydrocarbon resin from a hydrocarbon oil which has been physically separated from tar produced in the vapor phase pyrolysis of petroleum oil and which is free from and of greater volatility than the pitch of said tar, said hydrocarbon oil containing in addition to hydrocarbons boiling between 210C and 350C which are not polymerizable by the application to said oil of heat alone but which are polymerizable to catalytic resin polymer by treating said oil with a resin-producing catalyst, other hydrocarbons boiling between 210C and 350C which are polymerizable to catalytic resin polymer by treating said oil with a resin-producing catalyst but which last-mentioned hydrocarbons are also polymerizable to heat resin polymer by the application to said oil of heat alone, said last mentioned hydrocarbons being present in said hydrocarbon oil in amount greater than approximately 15% of the total unsaturation present in said hydrocarbon oil boiling between 210C and 350C as determined by bromine titration, comprising polymerizing in admixture both types of said polymerizable hydrocarbons contained in said hydrocarbon oil to form catalytic resin polymer by treating said hydrocarbon oil with a resin-producing catalyst.

Method for Treating Oil—Patent #2,387,250—Harold C. Eddy, assignor to Petrolite Corporation, Ltd. A process of purifying low water content mineral oils to remove water-soluble or water-wettable impurities contained in said oils which oils also contain naturally-occurring emulsifying agents tending to stabilize droplets of relatively fresh water when dispersed in the oil, comprising: forming an emulsion by dispersing relatively fresh water in said oil in the presence of an organic demulsifying agent in an amount from approximately 5 to 50% of the amount required to break said emulsion in the absence of an electric field, whereby an oil-continuous emulsion is obtained, said dispersing step being performed by mixing the oil and the relatively fresh water with such intensity as to disperse this water in the oil to form droplets coexisting with original impurities; subjecting said oil-continuous emulsion to the action of an electric field of sufficient intensity to coalesce in a large measure the dispersed water and impurities; separating the electrically-treated constituents to produce a body of purified oil substantially freed from the undesired impurities and a body of substantially oil-free water comprising the impurities removed from said oil; and separately recovering the purified oil.

Conversion of Hydrocarbon Oils—Patent #2,387,309—William J. Sweeney, assignor to Standard Oil Development Co. A process for producing gasoline which comprises passing a hydrocarbon oil boiling above gasoline through a cracking zone, contacting said oil within said cracking zone with an active cracking catalyst while at a temperature above 850F, maintaining said oil in said cracking zone for a period sufficient to convert a substantial portion of said oil into gasoline constituents, fractionating the cracked products to segregate a heavy naphtha fracton having a boiling range above 160F and below the end point of gasoline, an intermediate fraction having a boiling range above 100 F and below said heavy naphtha fraction, a light naphtha fraction boiling above 50F and below said intermediate naphtha fraction containing substantial quantities of olefinic constituents and being substantially free of aromatic constituents, passing said light naphtha fraction to an alkylating zone, introducing isoparaffinic hydrocarbons into said alkylating zone in an amount in excess of the olefinic content of said light naphtha fraction, controlling conditions within said alkylating zone to react said isoparaffins with the olefins contained in said light naphtha fraction to form a substantially saturated alkylate product, treating said intermediate naphtha fraction to remove olefins therefrom, and thereafter combining said intermediate fraction substantially free of said olefins with said heavy naphtha fraction and with the alkylate product to form gasoline.

Hydrocarbon Oil — Patent #2,387,501 — Melvin A. Dietrich, assignor to E. I. du Pont de Nemours and Co. A hydrocarbon oil having incorporated therein a small proportion, at least 0.01%, of an oil-soluble polymeric N-aliphatic acrylamide having a molecular weight of at least 1000 in which the aliphatic group contains an open chain of at least 8 atoms of which not more than 2 are interrupting atoms of the class consisting of oxygen and sulphur and the rest are carbon atoms.

Conversion of Hydrocarbon Oils—Patent #2,387,508—Arthur R. Goldsby, assignor to The Texas Company, N. Y. The process which comprises subjecting a normally liquid saturated naphtha hydrocarbon in the substantial absence of unsaturated hydrocarbons to the action of an aluminum halide isomerization catalyst in the presence of a small amount of hydrogen halide at an elevated temperature up to about 275F such that substantial isomerization to normally liquid naphtha hydrocarbon occurs without substantial formation of hydrocarbons having either an increased or a decreased number of carbon atoms per molecule and separately subjecting the resulting isomerized product to reforming by contact with solid adsorptive cracking catalyst at a temperature in the range 800 to 1000F whereby substantial conversion to isomerized hydrocarbons occurs.

Core Oil—Patent #2,387,827—Joseph N. Borglin, assignor to Hercules Powder Co. A core oil comprising as essential ingredients from 5 to 95% of polymerized rosin and from 10 to 65% of a drying oil, said percentages being based upon the non-volatile ingredients in the core oil.

Refining Aromatic Oils—Patent #2,387,893—Harold J. Hepp, assignor to Phillips Petroleum Company. The process of separating aromatic hydrocarbons essentially free from cyclopentadiene and methylcyclopentadiene and dimers thereof from crude aromatic oils containing said aromatic hydrocarbons and cyclopentadiene and methylcyclopentadiene and simultaneously separately recovering monomeric cyclopentadiene and methylcyclopentadiene therefrom which comprises continuously passing said crude aromatic oil into a fractionating column the kettle of which is provided with a reboiler, affecting said introduction at a mid-point of said column, maintaining the kettle of said column at a temperature of 350 to 500F by means of said reboiler, subjecting material flowing downwardly in said column and comprising dimers of cyclopentadiene and methylcyclopentadiene to temperatures of 350 to 500F in the lower part of said column for a period of time of between 0.5 and 5 hours and thereby converting all of said dimers to monomers, passing dimer-free material containing monomeric cyclopentadiene and methylcyclopentadiene upwardly in said column, operating said column at a pressure of 25 to 150 pounds per square inch gauge, maintaining the concentration of monomeric cyclopentadiene and methylcyclopentadiene and the temperature in the upper part of said column such as to substantially preclude dimerization of said monomeric material therein, refluxing the top of said column, withdrawing from the column at a point well below the top thereof at least one fraction containing the aromatic hydrocarbons of the feed and essentially free from cyclopentadiene and methylcyclopentadiene and dimers thereof, withdrawing as the overhead from said column an overhead fraction consisting essentially of hydrocarbons boiling below benzene and comprising monomeric cyclopentadiene and methylcyclopentadiene in amount essentially corresponding to the content thereof both as monomer and dimer in the original crude aromatic oil.

Lubrication—Patent #2,387,959—Amos T. Knutson and Eldon F. Graves, assignors to The Lubri-Zol Corp. A liquid extreme pressure lubricant for use in the crankcase of internal combustion engines comprising mineral lubricating oil and an amount of an addition agent comprising a sulphur-free organic derivative of carbonic acid sufficient to increase the load carrying capacity of the mineral lubricating oil so as to prevent seizure and scoring of bearings lubricated thereby when operated under pressures of at least 10,000 pounds per square inch.

Lubricating Oil—Patent #2,388,047—Elliott Alfred Evans and John Scotchford Elliott, assignors to C. C. Wakefield and Co. Ltd. An extreme pressure lubricating composition comprising a lubricating oil base having dispersed therein a reaction product of sulphur monochloride and sulphur with an aromatic hydroxy-substituted ester, said reaction product comprising a substantial proportion of aromatic hydroxy-substituted polysulphide containing at least three sulphur atoms to the molecule and having an ester substitutent, said reaction product being in sufficient amount to substantially increase the filmrupture strength of said lubricating oil base.

Petroleum Conversion Process—Patent #2,388,055—Charles E. Hemminger, assignor to Standard Oil Development Co. A continuous method for producing gasoline from a relatively heavy hydrocarbon oil in a multi-stage operation which comprises discharging the heavy oil into a viscosity reducing zone containing a quantity of subdivided hot powdered coke in the form of a fluidized mass, permitting the oil to remain in contact with the said powdered coke for a sufficient period of time to convert a substantial quantity of said oil into vapors containing gas oil, withdrawing said vapors from the viscosity reducing zone and discharging the vapors into a cracking zone containing a cracking catalyst in the form of a fluidized mass, permitting the vapors to remain in contact with said catalyst for a sufficient period of time to effect a substantial conversion to hydrocarbons boiling within the gasoline range, recovering a gasoline of improved octane rating from said cracking zone, reheating the mass of powdered coke by combustion and returning the heated coke uncooled to the viscosity reducing zone in quantities sufficient to supply the heat required for the reaction.

Lubricant—Patent #2,388,057—Robert D. Herlocker, Milton Paul Kleinholz, and Franklin M. Watkins, assignors to Sinclair Refining Company. An improved turbine oil which comprises a petroleum lubricating oil containing a proportion of (di-ethanolaminomethyl)-di-tert.-amylphenol effective to retard rusting.

Lubricant—Patent #2,388,058—Robert D. Herlocker, Milton Paul Kleinholz, and Franklin M. Watkins, assignors to Sinclair Refining Company. An improved turbine oil which comprises a petroleum lubricating oil containing a proportion, effective to retard rusting, of a diaminomethane derivative.

Lubricant—Patent #2,388,059—Robert D. Herlocker, Milton Paul Kleinholz, and Franklin M. Watkins, assignors to Sinclair Refining Company. An improved turbine oil which comprises a petroleum lubricating oil containing a proportion, effective to retard rusting, of a diaminomethane derivative.

Lubricants—Patent #2,388,074—John A. Patterson and Rush F. McCleary, assignors to The Texas Co. A lubricant comprising a hydrocarbon oil and a small quantity, sufficient to impart oxidation-resistant properties to said oil, of an oil-miscible metal derivative of the oil-soluble phenolic compositions derived from an oil extracted from a member of the Anacardium genus of the Anacardiaceae family.

Process for Stabilizing a Petroleum Oil—Patent #2,388,076—Gerald E. Phillips, assignor to Standard Oil Development Co. A process for stabilizing a petroleum oil fraction of essentially the motor fuel range and containing a substantial quantity of unsaturated compounds, which comprises contacting the same in liquid phase with a bed of an activated clay catalyst at a temperature at least as high as 300F and controlling the temperature within the reaction zone by introducing water into the catalyst bed at a plurality of points and only in an amount which is not more than about 1%, based on the feed stock.

Lubricant — Patent #2,388,083 — Maurice Reswick, assignor to Standard Oil Development Co. A lubricant comprising a major proportion of mineral lubricating oil, about 5-25% by weight of a lead soap of naphthenic acids containing at least one cyclic nucleus, and a small amount of a hydroxy aromatic hydrocarbon having a water-solubility less than about 5 grams per 100cc. of water at 20C.

Process of Acid-Treating a Thermally Cracked Petroleum Distillate—Patent #2,388,087—William J. Ryan and Marcus T. Kendall, assignors to The Texas Co. A process of acid treating a thermally cracked petroleum distillate to remove gumforming constituents which comprises contacting the distillate with an acid sludge containing about 40 to 60 per cent H_2SO_4, separating the distillate from the resulting sludge, then contacting the distillate with sulfuric acid of about 55 to 60 per cent strength selected from the group consisting of fresh sulfuric acid and regenerated sludge acid, and separating the distillate from the sludge formed, the treated distillate being characterized by a reduced gum content and good color.

Lubrication of Automotive Tires—Patent #2,388,114—Malcolm B. Boyce. In a wheeled vehicle having pneumatic tires on its wheels, and propulsion means for moving the vehicle over a road surface, means for reducing friction between the tread portion of a tire and the road surface, comprising a nozzle arranged and adapted to apply a film of liquid only on the tread portion of the tire at a region thereof which is moving downward toward the road surface, whereby said film is carried on the tread into intervening lubricating relation between the tread and the road surface, means carried on the vehicle for storing liquid, and means for supplying liquid from said storing means to said nozzle, said last named means being operative in response to the speed of the vehicle to vary the amount of liquid supplied to said nozzle.

Turbine Oil—Patent #2,388,132—Paul W. Fischer and Vance N. Jenkins, assignors to Union Oil Company of California. An anti-corrosion composition comprising a mineral oil fraction of lubricating viscosity containing a minor proportion of oil-soluble imido-esters free from amides and other oil-soluble ammonia derivatives.

Cleaning and Lubricating Emulsion—Patent #2,388,153—Hugh H. Jones, assignor to Hugh Jones Products Co. A lubricant mixture for molds used in molding rubber comprising trisodium phosphate from 1 to 4 per cent, Turkey red oil 1.2 to 2.1 per cent, a mixture of pine oil and an alkali metal water soluble soap in the proportions of approximately 3 parts pine oil to one part of soap 0.4 to 1.2 per cent, gum arabic mucilage 0.1 to 0.4 per cent and the remainder water.

Mineral Oil Composition—Patent #2,388,199—Robert H. Williams and Everett W. Fuller, assignors to Socony-Vacuum Oil Company. An improved mineral oil composition comprising a viscous mineral oil fraction having in admixture therewith a minor proportion, sufficient to depress the pour point of said oil fraction, of a metal salt of an acidic, phosphorus-and sulfur- containing reaction product, said reaction product having been obtained by reaction of phosphorus pentasulfide and an olefinic alcohol, and said olefinic alcohol having been obtained by first halogenating a petroleum wax having at least twenty carbon atoms to form a halogenated petroleum wax and thereafter substantially dehalogenating said halogenated petroleum wax with aqueous alkali to form said olefinic alcohol, said salt possessing pour point depressant action.

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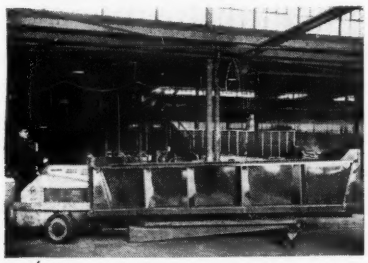
Long, Heavy Loads Transported on Dolly By Power Truck

Long and heavy objects such as the dump-truck body shown in the accompanying illustration may be transported readily by means of a two-wheeled dolly and a low-lift platform truck. The body, which is fabricated by welding steel plates, is approximately 15 feet long, 3 feet high, and 6 feet wide. It is lifted onto the dolly by overhead crane.

The dolly is made from steel plate, with the sides shaped and turned down as illustrated. Forward end is mounted on wheels, and the rear end rests on the floor. Upper surface of the dolly is practically at uniform level, at a height making it easy for the truck's platform to be pushed underneath it.

By lifting the rear end of the dolly off the floor the entire load is supported on wheels, four on the industrial truck and two on the dolly. In this position this and similar loads may be moved anywhere in plant, or transported to stockroom or to shipping platform.



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News releases describing new products or new equipment in the field of lubrication and its application will be welcomed by the editor, as will pictures, charts, line drawings, etc. Please address communications to:

Mr. B. H. Jennings, Editor,
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Corrosion Test Strips

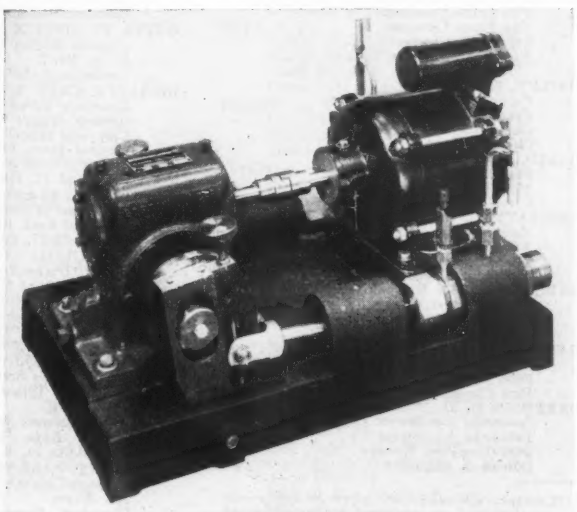
Randall and Sons, 2512 Etna Street, Berkeley 4, California, have recently put on the market a new item, the *Bearing Corrosion Test Strip*. This small device was developed in the laboratories of a large oil company to determine the "existent corrosivity" of new and used engine oils.

The Type C Bearing Corrosion Test Strip is for use with lead-copper bearings. Lead is plated on thin strips of copper ¼ in. wide by 4 in. long in seven steps from 3/1,000,000 to 100/1,000,000 in thickness. The "existent corrosivity" is measured visually by observing the number of steps removed after one hour immersion in the test oil. The strip can either be attached to the dipstick or used in laboratory apparatus designed to duplicate engine conditions.

Additional information including a sample strip and directions for use may be had by writing to Randall and Sons.

High Pressure Variable Stroke Pump

Developed in collaboration with the Universal Oil Products Company, the "PRECISION"-U. O. P. Duplex High Pressure Pump, Variable Stroke, meets the requirements for a sturdy, continuous-duty, high-pressure, adjustable stroke pump for use in pilot plant operations, experimental pressure work, and for many industrial applications. The pump is of the duplex type, with individual cylinders permitting two different types of liquids to be pumped simultaneously, or where increased volume is desired above the capacity of a single cylinder, both cylinders can be piped in parallel. The manufacturer claims that because of the compact design these pumps are particularly adaptable to most applications where space is at a premium. The design of the duplex pump is said to permit continuous operation and will maintain a given flow rate continuously, delivering full rated output at maximum rated pressure. Volumetric efficiency throughout the full range is over 90% according to the manufacturer. For further information, write to precision Scientific Company, 1754 North Springfield Ave., Chicago 47, Ill.



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119 W. Woodbine Street
Chevy Chase, Maryland

BAYSTER, N. G.
American Oil Co.
1008 Western Avenue
Pittsburgh 12, Pennsylvania

BEACH, CLAIR A.
National Refining Co.
National Refining Co.
Room 1119 Commercial Bank Building
Chicago 4, Illinois

BEALL, ALMON L.
Wright Aeronautical Corp.
P. O. Box 342
Packanack Lake, New Jersey

BEAN, LOUIS K.
The Texas Co.
The Texas Co.
1204 McCormick Building
Chicago 4, Illinois

BECK, CLARENCE J.
Globe Steel Tubes Co.
2958 North 21st Street
Milwaukee, Wisconsin

BEERS, A. DODSON, JR.
Carnegie-Illinois Steel Corp.
644 Grant Street
Gary, Indiana

BELFIT, ROBERT W.
Scovill Mfg. Co.
Scovill Mfg. Co.
99 Mill Street
Waterbury 91, Connecticut

BENJAMIN, I. N.
Socony Vacuum Oil Co.
2136 Minnesota Avenue
Duluth, Minnesota

BERGMAN, H. E.
Bowser, Inc.
Bowser, Inc.
110 N. Franklin Street
Chicago, Illinois

BETTS, FREDERICK H.
Colonial Beacon Oil Co.
R. D. No. 2
Castleton-on-theHudson, New York

BIERLEIN, CARL A.
Cleveland Diesel Engine Div.
General Motors Corp.
Cleveland Diesel Engine Div.
General Motors Corp.
2160 W. 106th Street
Cleveland 11, Ohio

BINNS, H. M. STANLEY
Cincinnati Milling Machine Co.
5857 Red Bank Road
Cincinnati 27, Ohio

BLACK, PAUL H.
Cornell University
Assoc. Prof. of Mach. Design
Cornell University
Ithaca, New York

BODMAN, SAM W., JR.
Swan Finch Oil Co.
Swan Finch Oil Co.
201 N. Wells Street
Chicago 6, Illinois

BOIE, ALVIN E.
Allis Chalmers Mfg. Co.
6921 W. Rogers Street
West Allis 14, Wisconsin

BOLLINGER, PARK G.
Federated Metals Div.
Iola Street
Glenshaw, Pennsylvania

BOORD, HARRY W.
American Oil Co.
American Oil Co.
1301 Grant Building
Pittsburgh, Pennsylvania

BORDEN, LLOYD KYRON
Borden Oil Company
2341 Henry Street
Sheboygan, Wisconsin

BOSWELL, THOMAS L.
Elgin National Watch Co.
Elgin National Watch Co.
107 National Street
Elgin, Illinois

BOURNE, JOHN P.
Standard Oil Co. (California)
3670 Fillmore Street
San Francisco 23, California

BOWDEN, WILLIAM
Firestone Tire & Rubber Co.
1945 11th Street
Cuyahoga Falls, Ohio

BOWEN, ALFRED F.
Socony Vacuum Oil Co.
1193 Virginia Avenue
Lakewood, Ohio

BOWERS, GEORGE F.
Standard Oil Co. (Ind.)
Standard Oil Co. (Ind.)
910 S. Michigan Avenue
Chicago 80, Illinois

BOWMAN, VIRGIL E.
Socony Vacuum Oil Co.
72 S. 6th Avenue
LaGrange, Illinois

BOYD, JOHN
Westinghouse Electric Corp.
Westinghouse Electric Corp.
Research Lab.—Ardmore Boulevard
East Pittsburgh, Pennsylvania

BRACE, R. LYLE
Brace Engineering Company
Brace Engineering Company
317 Peoples State Bank Building
Indianapolis 4, Indiana

BRADLEY, JOHN C.
The American Brass Co.
The American Brass Co.
Waterbury 88, Connecticut

BRAND, EDGAR E.
L. Sonneborn Sons, Inc.
L. Sonneborn Sons, Inc.
400 West Madison Street
Chicago 28, Illinois

BRENHOLTS, GEORGE W.
N. Y. and N. J. Lubricant Co.
N. Y. and N. J. Lubricant Co.
2328 Lamberton Road
Cleveland Heights 18, Ohio

BREWER, ALLEN F.
The Texas Co.
The Texas Co.
135 E. 42nd Street
New York, New York

BREZA, GEORGE
Mackintosh-Hemphill Co.
Mackintosh-Hemphill Co.
901 Bingham Street
Pittsburgh 3, Pennsylvania

BRIGHT, JOHN G.
Socony Vacuum Oil Co., Inc.
1209 South Negley Avenue
Pittsburgh 17, Pennsylvania

BRIZZOLARA, JAMES
Standard Oil Co.
Standard Oil Co.
715 East 10th Street
Wichita 1, Kansas

**Company affiliations are given in italics—addresses indicated are preferred mailing addresses.*

BRIZZZOLARA, RALPH D.
American Steel Foundries
American Steel Foundries
410 North Michigan Avenue
Chicago 11, Illinois

BROOKS, W. M.
Allis Chalmers Supercharger
3077 S. 54th Street
Milwaukee 14, Wisconsin

BROSSEAU, LOUIS C.
Hodson Corporation
Hodson Corporation
5311 W. 66th Street
Chicago, Illinois

BROWN, ELTON S.
Standard Oil Co. (N. J.)
Standard Oil Co. (N. J.)
P. O. Box 713
Charleston 23, West Virginia

BUDERUS, W. H.
Sinclair Refining Co.
3207 Royton Road
Toledo 9, Ohio

BURG, MARTIN S.
Dodge Chicago (Chrysler)
Dodge Chicago (Chrysler)
7401 South Cicero Avenue
Chicago, Illinois

BURT, LOUIS B.
Lincoln Engineering Co.
8022 Drexel Avenue
Chicago 19, Illinois

BURWELL, ARTHUR WARNER
Alox Corp.
Alox Corp.
P. O. Box 556
Niagara Falls, New York

BLAISDELL, CHARLES C.
Penola, Inc.
20141 Gardendale Street
Detroit 21, Michigan

CALLAHAN, JOHN X. J.
12 Chestnut Hill, Inkerman
Pittston, Pennsylvania

CAMBRON, JAMES S.
Hodson Corporation
Wade Park Manor
Cleveland, Ohio

CAMPBELL, MILTON H.
Standard Oil Co. (Ohio)
Standard Oil Co. (Ohio)
2127 Cornell Road
Cleveland 6, Ohio

CARLIN, AUSTIN E.
Lake Shore Oil Co.
Lake Shore Oil Co.
5331 West 65th Street
Chicago, Illinois

CASSIDY, R. G.
Filmite Oil Corp.
Filmite Oil Corp.
Station K
Milwaukee 10, Wisconsin

CHALFANT, CHARLES N.
G. Whitfield Richards
19961 Meyers Road
Detroit 21, Michigan

CHALMER, STANLEY OSRIC
Commonwealth Oil Refineries, Ltd.
Commonwealth Oil Refineries, Ltd.
90 William Street
Melbourne, C1, Australia

CHAPPELL, PAUL F.
American Oil Co.
8 Mayflower Court
Pikesville 8, Maryland

CHRISTIAN, C. W.
General Petroleum Corp.
General Petroleum Corp.
108 West 2nd Street
Los Angeles 12, California

CLARK, WILLIAM F.
Weinman Pump & Supply Co.
Weinman Pump & Supply Co.
207-209 Blvd. Allies
Pittsburgh 22, Pennsylvania

CLARK, WILSON J.
C. H. Clark Oil Company
C. H. Clark Oil Company
2625 E. 76th Street
Cleveland 4, Ohio

CLINGEN, JOHN, JR.
Alemite Co. of Wis., Inc.
Alemite Co. of Wis., Inc.
1010 Van Buren Street
Milwaukee, Wisconsin

COAKLEY, FRANK N.
Republic Steel Co.
1320 Bunts Street
Lakewood 7, Ohio

CONOVER, HUGH B.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
434 Fifth Avenue
Pittsburgh, Pennsylvania

CONOVER, NEILSON B.
The Hodson Corp.
The Hodson Corp.
907 Market Street
National Bank Building
Philadelphia 7, Pennsylvania

CONTURBA, CHARLES E.
The Hodson Corp.
226 Ingram Avenue
Pittsburgh, Pennsylvania

COOK, CHARLES FAIRALL
Pullman Std. Car Mfg. Co.
1605 Euclid Avenue
Chicago Heights, Illinois

COOK, KENNETH S.
Keystone Asphalt Prod. Co.
Keystone Asphalt Prod. Co.
Center Avenue
Chicago Heights, Illinois

COULTER, R. E.
Alemite Co. of Wis., Inc.
Alemite Co. of Wis., Inc.
1010 N. Van Buren Street
Milwaukee 2, Wisconsin

COWLEY, CLAUDE F.
Fiske Bros. Refining Co.
Fiske Bros. Refining Co.
6-225 Gen. Mtrs. Building
Detroit 2, Michigan

CRAINE, S. D.
Socony Vacuum Oil Co.
715 Hillside Avenue
Glen Ellyn, Illinois

CRANKSHAW, EDWIN
Cleveland Graphite Bronze Co.
Cleveland Graphite Bronze Co.
17000 St. Clair Street
Cleveland 10, Ohio

CUTHBERT, WILLIAM LESLIE
Esso Standard Oil, S. A.
Esso Standard Oil, S. A.
22 Abercrombie Street
Port of Spain, Trinidad, B. W. I.

DANSE, L. A.
General Motors Co.
General Motors Co.
15-223 Gen. Mtrs. Bldg.
Detroit 2, Michigan

DARDING, GEORGE A.
Wright Aeronautical Corp.
6944 Silverton Avenue
Silverton 13, Ohio

DAUBERT, G. A.
Nox-Rust Corp.
Nox-Rust Corp.
2429 South Halsted Street
Chicago 8, Illinois

DAVIDSON, ROBERT T.
Sun Oil Co.
Sun Oil Co.
6331 Southern Boulevard
Youngstown, Ohio

DAVIS, GEORGE C.
Davis-Howland Oil Corp.
Davis-Howland Oil Corp.
South Avenue at Griffith
Rochester 7, New York

DAVIS, GEORGE H.
Shell Oil Co., Inc.
Shell Oil Co., Inc.
1102 Grant Building
Pittsburgh 19, Pennsylvania

DAY, A. L.
Standard Steel Spring Co.
7564 Warner Avenue
St. Louis, Missouri

DE MARTONFALVY, IVAN CHARLES
Uni-Gun Lubrication Equipment Ltd.
Uni-Gun Lubrication Equipment Ltd.
Argyle House
29/31 Euston Road
London, England

DENIGAN, EDWARD P.
Blaw Knox Co.
Blaw Knox Co.
829 Beaver Avenue
Pittsburgh 12, Pennsylvania

DEUTSCH, WILBUR
Trabon Engineering Corp.
Trabon Engineering Corp.
1022 Empire Building
Pittsburgh 22, Pennsylvania

DIEBOLD, EARLE M.
American Brake Shoe Co.
American Brake Shoe Co.
3208 Grant Building
Pittsburgh 19, Pennsylvania

DIX, RALPH GOODMAN
Cities Service Oil Co.
1136 Broad Avenue, N. W.
Canton 3, Ohio

DONKER, A. E.
Honan-Crane Corp.
Honan-Crane Corp.
50 Church Street
New York, New York

DORNER, JACK D.
Dorner Co. & Honan-Crane Corp.
4101 N. Stowell Street
Milwaukee 11, Wisconsin

DOUSSEAU, EDWIN L.
L. R. Kerns Co.
L. R. Kerns Co.
2657 E. 95th Street
Chicago 17, Illinois

DOYLE, PAUL J.
Republic Steel Corp.
Republic Steel Corp.
3100 E. 45th Street
Cleveland, Ohio

DRAKE, WILLIAM L.
Sinclair Refining Co.
2114 East Woodstock Place
Milwaukee 2, Wisconsin

DROKE, JAMES CARL
The Texas Company
The Texas Company
332 South Michigan Avenue
Chicago 4, Illinois

EBERLE, WILLIAM FREDERICK
The Neville Co.
The Neville Co.
Neville P. O.
Pittsburgh 25, Pennsylvania

EDER, NORMAN GEORGE
Kendall Refining Co.
Kendall Refining Co.
Bradford, Pennsylvania

EHRET, E. J.
Farval Corp.
Farval Corp.
327 South LaSalle Street
Chicago 4, Illinois

EKLUND, PHILLIP R.
Westinghouse Electric Corp.
408 Whitney Avenue
Pittsburgh 21, Pennsylvania

ELLIMAN, SAMUEL
Vigzol Oil Refining Co.
Vigzol Oil Refining Co.
113 Park Street
London, W 1, England

ENCK, HENRY S.
Jack and Heintz, Inc.
17507 Throckley Avenue
Cleveland 20, Ohio

ENNIS, H. E.
The Texas Co.
The Texas Co.
31 Terminal Way
Pittsburgh 19, Pennsylvania

EVANS, DOUGLAS N.
Inland Steel Co.
Inland Steel Co.
East Chicago, Indiana

EVANS, THOMAS J., JR.
Socony Vacuum Oil Co.
9831 S. Seeley Street
Chicago 43, Illinois

EVERITT, WILLIAM THEODORE
Eastman Kodak Co.
Eastman Kodak Co.
Kodak Park
Rochester, New York

EVERSZ, HOMER M.
B-W Superchargers, Inc.
4327 North 17th Street
Milwaukee 9, Wisconsin

EWBANK, WALTER JAMES
Briggs Clarifier Co.
Briggs Clarifier Co.
1339 Wisconsin Avenue
Washington, D. C.

FAIRCHILD, SHERMAN M.
Fairchild Engine & Airplane Corp.
Fairchild Engine & Airplane Corp.
30 Rockefeller Plaza
New York 20, New York

FINK, SAM M.
Alemite Co. of Pittsburgh
Alemite Co. of Pittsburgh
201 Shady Avenue
Pittsburgh 6, Pennsylvania

FINKELMAN, JOHN L.
The Warren Refining & Chemical Co.
The Warren Refining & Chemical Co.
308 Euclid Avenue
Cleveland 14, Ohio

FINN, J. C.
Detroit Diesel Engine Div.
Detroit Diesel Engine Div.
13400 W. Outer Drive
Detroit 13, Michigan

FISHER, C. W.
Gulf Refining Co.
Route No. 3
Medina, Ohio

FITCH, L. W.
Dingle-Clark Co.
Dingle-Clark Co.
1248 Engineers Building
Cleveland 14, Ohio

FOLLMER, CARL FRED
Thompson Aircraft Products Co.
R. F. D. No. 2, Box 150
Rome, Ohio

FOX, ALEX P.
Lincoln Engineering Co.
Lincoln Engineering Co.
5701 Natural Bridge Avenue
St. Louis 20, Missouri

FRASER, HAROLD M.
International Lubricant Corp.
International Lubricant Corp.
P. O. Box 390
New Orleans 1, Louisiana

FREDERICKS, DONALD E.
L. R. Kerns Co.
6942 S. Crandon Street
Chicago, Illinois

FREDERICKS, W. CARLETON
Standard Oil Co. (Ind.)
Standard Oil Co. (Ind.)
910 South Michigan Avenue
Chicago 80, Illinois

FREEMAN, EDWIN W.
Cities Service Refining Corp.
Cities Service Refining Corp.
Hodges Street
Lake Charles, Louisiana

FREMON, E. B.
Socony Vacuum Oil Co., Inc.
Socony Vacuum Oil Co., Inc.
4140 Lindell Street
St. Louis 8, Missouri

FROHMAN, OSCAR
Ampco Metal, Inc.
4478 North Cramer Street
Milwaukee 11, Wisconsin

FULLER, DUDLEY D.
Columbia University
Department of Mechanical Engr.
Columbia University
New York 27, New York

FITZGERALD, CORNELIUS F.
Alemite Co. of Pittsburgh
85 Hilton Avenue
Youngstown 5, Ohio

FLETCHER, HARRY B.
Honan-Crane Corporation
Honan-Crane Corporation
50 Church Street
New York 7, New York

GATES, PAUL J.
The F. D. Johnson Co.
The F. D. Johnson Co.
1814 East 40th Street
Cleveland 3, Ohio

GENTHE, WALTER A.
The Texas Co.
The Texas Co.
332 South Michigan Avenue
Chicago 4, Illinois

GEORGI, CARL W.
Quaker State Oil Refining Corp.
Quaker State Oil Refining Corp.
164 Chandler Street
Buffalo 7, New York

GESDORF, EDWARD J.
The Farval Corp.
3534 Radcliffe Road
Cleveland Heights 21, Ohio

GILL, FRANK P.
Adam Cook's Sons Inc.
Adam Cook's Sons Inc.
5 Stiles Street
Linden, New Jersey

GILLETTE, CHARLES R.
New Departure Div., Gen. Mtrs. Corp.
Vanderbilt Road
Bristol, Connecticut

GILLMAN, T. E.
Chetwin, Newark and Co., Ltd.
71 Glennie Road
London, S. E. 27, England

GITZEN, JOSEPH A.
Delta Oil Products Co.
Delta Oil Products Co.
6263 North Teutonia Avenue
Milwaukee 9, Wisconsin

GJERDE, M. D.
Standard Oil Co. (Ind.)
Standard Oil Co. (Ind.)
910 South Michigan Avenue
Chicago 80, Illinois

GLENN, BRUCE W.
L. R. Kerns Co.
L. R. Kerns Co.
2657 East 95th Street
Chicago 17, Illinois

GOBLE, R. D.
Skinner Purifiers, Inc.
2331 North 8th Street
Milwaukee 6, Wisconsin

GODARD, P. W.
Sinclair Refining Co.
904 Peachtree Street, N. E.
Atlanta, Georgia

GODDARD, HOMER A.
Gulf Oil Corp.
Gulf Oil Corp.
Gross Street and P. R. R.
Pittsburgh 6, Pennsylvania

GORDON, ROBERT M.
Gordon Lubricating Co.
Gordon Lubricating Co.
Gregg Street
Carnegie, Pennsylvania

GOWER, CHARLES ARTHUR EDWARD
Socony Vacuum Oil Co., Inc.
Socony Vacuum Oil Co., Inc.
Federal Reserve Bank Building
Kansas City, Missouri

GRAHAM, THOMAS H.
The Hodson Corp.
218 Wood Street
Ellwood City, Pennsylvania

GRASSO, L. A.
The Texas Co.
The Texas Co.
31 Terminal Way
Pittsburgh 19, Pennsylvania

GRAVENSTRETER, JAMES P.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
Gary Steel Works
Gary, Indiana

GRAVES, ELDON F.
Dow Chemical Co.
4014 Oak Court
Midland, C-8, Michigan

GRAY, L. J., JR.
J. G. Griffith Co.
J. G. Griffith Co.
1251 Union Trust Building
Pittsburgh 19, Pennsylvania

GRAY, L. L.
Gray Company, Inc.
Gray Company, Inc.
60 Eleventh Avenue, N. E.
Minneapolis, Minnesota

GRAM, HAROLD
Dodge-Chicago
9643 South Merrill Avenue
Chicago 17, Illinois

HAAS, H. A.
Blackmer Pump Co.
Blackmer Pump Co.
915 Union Trust Building
Pittsburgh 19, Pennsylvania

HAGAN, R. J.
Republic Steel Corp.
Republic Steel Corp.
Youngstown 1, Ohio

HAGER, H. R.
Sun Oil Co.
Sun Oil Co.
990 Home Avenue
Akron, Ohio

HALDEMAN, RUSSELL R.
De Laval Steam Turbine Co.
De Laval Steam Turbine Co.
853 Nottingham Way
Trenton 2, New Jersey

HALL, JAMES F.
Ironsides Co.
Ironsides Co.
270 West Mound Avenue
Columbus 15, Ohio

HAMILTON, WILLIAM EARL
Tenn. Coal, Iron and R. R. Co.
2019 25th Street
Birmingham 8, Alabama

HANKOSKY, ANDREW
Carnegie Illinois Steel Corp.
R. R. No. 1
Gary, Indiana

HARPER, H. LEONARD
Aluminum Company of America
Aluminum Company of America
Gulf Building
Pittsburgh 19, Pennsylvania

HARRIS, RALPH N.
Pure Oil Co.
P. O. Box 806
Morgantown, West Virginia

HART, ALAN
The Franklin Oil & Gas Co.
The Franklin Oil & Gas Co.
Bedford, Ohio

HARTMAN, KENNETH D.
Pittibone Mulliken Corp.
2542 North 73rd Court
Elmwood Park 35, Illinois

HASTINGS, S. A.
Crane Packing Company
Crane Packing Company
1801 Cuyler Street
Chicago 13, Illinois

HAZENFIELD, MILO CO.
Lincoln Engineering Co.
Lincoln Engineering Co.
134-136 S. Whitfield Street
Pittsburgh 6, Pennsylvania

HEATH, GEORGE F.
The Farval Corp.
The Farval Corp.
3249 East 80th Street
Cleveland 4, Ohio

HEILAND, JOHN GEORGE
Bell and Howell
1339 Center Ave.
Des Plaines, Illinois

HENKEL, HULL
Metal Lubricants Co.
3211 S. Wood Street
Metal Lubricants Co.
Chicago 8, Illinois

HERSEY, MAYO D.
Massachusetts Inst. of Tech.
Building 31
Massachusetts Inst. of Tech.
Cambridge 39, Massachusetts

HEWITT, JAMES R.
Jos. Woodwell Co.
R. D. No. 11
Clairton Boulevard
Pittsburgh 10, Pennsylvania

HEYER, ARTHUR J.
Sinclair Refining Co.
Sinclair Refining Co.
3030 Euclid Avenue
Cleveland, Ohio

HODSON, ELLIOTT W.
Hodson Corp.
Hodson Corp.
5301 W. 66th Street
Chicago 38, Illinois

HODSON, LEE N.
Hodson Corp.
Hodson Corp.
5301 W. 66th Street
Chicago 38, Illinois

HODSON, W. D.
Hodson Corp.
Hodson Corp.
5301 W. 66th Street
Chicago 38, Illinois

HODSON, WALTER H.
Hodson Corp.
Hodson Corp.
5301 W. 66th Street
Chicago 38, Illinois

HOFFMAN, GEORGE
Elco Lubricant Corp.
2635 East 128th Street
Cleveland 20, Ohio

HOFMEISTER, HAROLD P.
Socony Vacuum Oil Co.
2355 N. 82nd Street
Wauwatosa, Wisconsin

HOLLINGSWORTH, DWIGHT F.
E. I. duPont deNemours and Co.
E. I. duPont deNemours and Co.
1007 Market Street
Wilmington 98, Delaware

HOLT, JAMES OSCAR
Sinclair Refining Co.
3511 Neil Street
Raleigh, North Carolina

HORWITZ, ALBERT S.
E. F. Houghton & Co.
E. F. Houghton & Co.
Quint and Davidson Street
San Francisco 24, California

HOWELL, K. M.
Standard Oil Co. (Ohio)
62 Pinehurst Avenue
Youngstown 5, Ohio

HUBKA, VENCEL A.
American Manuf. Co. of Texas
532 South Oswego Avenue
Tulsa, Oklahoma

HUEGEL, ARTHUR J.
Evans Engineering Co.
Evans Engineering Co.
2930 W. Burleigh Street
Milwaukee 10, Wisconsin

HULETT, W. E.
Socony Vacuum Oil Co.
1807 S. 10th Avenue
Maywood, Illinois

HUNTER, B. F.
Honan-Crane Corp.
403 E. Washington Street
Lebanon, Indiana

HURD, WILLIAM P., SR.
Socony Vacuum Oil Co.
10 Oakwood Avenue
Dayton 9, Ohio

ISBELL, HARVEY G.
Industrial Laboratory
Industrial Laboratory
U. S. Navy Yard
Mare Island, California

JACOBS, ROY W.
Aluminum Co. of America
Aluminum Club
New Kensington, Pennsylvania

JAESCHKE, ALFRED F.
National Refining Co.
National Refining Co.
122 South Michigan Avenue
Chicago, Illinois

JAMESON, HERBERT B.
Petroleum Equipment Co.
Petroleum Equipment Co.
3117 N. Broad Street
Philadelphia 32, Pennsylvania

JARMAN, J. T.
Allis Chalmers Mfg. Co.
Allis Chalmers Mfg. Co.
Milwaukee 1, Wisconsin

JAY, WILLIAM R.
Fiske Bros. Refining Co.
2353 Wildwood Boulevard
Toledo 9, Ohio

JENKIN, WILLIAM C.
Thompson Products, Inc.
10418 Sandusky Avenue
Cleveland 5, Ohio

JENKINS, HOWARD B.
Wheeling Steel Corp.
Wheeling Steel Corp.
Portsmouth, Ohio

JENKINS, WESLEY R.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
3426 East 89th Street
Chicago, Illinois

JENNINGS, A. J.
The Farval Corp.
The Farval Corp.
3249 East 80th Street
Cleveland 4, Ohio

JENNINGS, BURGESS H.
Northwestern Technological Inst.
Northwestern Technological Inst.
Sheridan Road and Noyes Street
Evanston, Illinois

JESTER, MAXWELL B.
Calumet Refining Co.
Calumet Refining Co.
4323 South Western Boulevard
Chicago 9, Illinois

JOHNSON, CHARLES B.
Pittsburgh Equitable Meter Co.
Pittsburgh Equitable Meter Co.
400 North Lexington Avenue
Pittsburgh 8, Pennsylvania

JOHNSON, DARRYL W.
Standard Oil Co.
Standard Oil Co.
414 West Michigan Street
Milwaukee 1, Wisconsin

JOHNSON, FRANK D.
Trabon Engineering Corp.
Trabon Engineering Corp.
1814 East 40th Street
Cleveland, Ohio

JOHNSON, WILLIAM O.
Gulf Refining Co.
3370 Altamont Road
Cleveland Heights 18, Ohio

JOHNSTON, H. W.
Standard Oil Co.
1664 Lee Road
Cleveland Heights, Ohio

JONES, HAROLD WILLIAM
Penola, Inc.
3724 Rolliston Road
Cleveland, Ohio

JONES, WILLIAM
Gulf Oil Corp.
121 South Pasadena Drive
Aspinwall 15, Pennsylvania

JONES, WILLIAM CARTER
Carbide and Carbon Chemicals Co.
Carbide and Carbon Chemicals Co.
230 North Michigan Avenue
Chicago 1, Illinois

JOYCE, EDWIN M.
Swan Finch Oil Corp.
107 East 48th Street
Indianapolis 5, Indiana

JUDS, ARTHUR F.
A. F. Juds Oil Co.
A. F. Juds Oil Co.
531 South Water Street
Milwaukee 4, Wisconsin

JUSTICE, R. W.
E. F. Houghton and Co.
260 Pennsylvania Avenue
Youngstown 4, Ohio

KARTHAUSER, CARL A.
Self
207 Investment Building
Pittsburgh 22, Pennsylvania

KASMARK, J. W.
Parker Appliance Co.
1883 Haldane Street
Cleveland 12, Ohio

KAY, LEWIS M.
Sinclair Refining Co.
332 Eighth Street
Atlanta, N. E., Georgia

KAYSER, HENRY W.
The Falk Corp.
2472 N. 66th Street
Wauwatosa 13, Wisconsin

KEELEY, G. F.
Stewart-Warner-Alemite
Stewart-Warner-Alemite
1826 West Diversey Street
Chicago, Illinois

KEMMERER, HAROLD RICHARD
Shell Oil Co., Inc.
Shell Oil Co., Inc.
P. O. Box 2527
Houston 1, Texas

KENTLEIN, John
H. K. Porter Co., Inc.
344 Hawthorne Road
Millvale 1, Pennsylvania

KENYON, RUSSELL W.
L. R. Kerns Co.
2010 Mayburn Street
Dearborn, Michigan

KERR, JOHN N.
Sun Oil Co.
554 West Judson Avenue
Youngstown 7, Ohio

KILIMANN, WILLIAM
C. M. St. P. & P. R. R.
1518 North 60th Street
Milwaukee, Wisconsin

KIMPEL, CLINTON B.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
Duquesne, Pennsylvania

KINSEY, JOHN D.
The Farval Corp.
The Farval Corp.
327 South LaSalle Street
Chicago 4, Illinois

KIPP, E. M.
Aluminum Co. of America
Aluminum Co. of America
New Kensington, Pennsylvania

KLASING, GEORGE V.
Alemite Co.
920 Cullom Street
Chicago 13, Illinois

KLEIN, BERNARD F.
Peroleum Advisers, Inc.
P. O. Box 333
Manasquan, New Jersey

KLEMGARD, EDWIN N.
U. S. Navy
3420—32nd Avenue, West
Seattle 99, Washington

KLUENDER, ARNOLD F.
L. R. Kerns Co.
172 West 14th Street
Chicago Heights, Illinois

KOCH, CLIFFORD
Canfield Oil Co.
Canfield Oil Co.
3216 East 55th Street
Cleveland 4, Ohio

KOHN, E. J.
Tenn. Coal, Iron and RR. Co.
Tenn. Coal, Iron and RR. Co.
P. O. Box 35—Ensley Station
Birmingham 8, Alabama

KRAEMER, HERMAN C.
Servel, Inc.
Servel, Inc.
Morton Avenue
Evansville 20, Indiana

KRAMER, EDWARD P.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
Munhall, Pennsylvania

KRAMER, W. EDWARD
Gulf Research & Development Co.
Gulf Research & Development Co.
P. O. Box 2038
Pittsburgh 30, Pennsylvania

KRAUS, CHARLES I.
Alemite Div.—Stewart-Warner Co.
Alemite Div.—Stewart-Warner Co.
1826 Diversey Parkway
Chicago, Illinois

KRAUS, ROBERT A.
Republic Steel Co.
Republic Steel Co.
116th and Burley Street
Chicago, Illinois

KRAUSE, WALLACE H.
Allis Chalmers Mfg. Co.
711 South 103rd Street
Milkaulkee 14, Wisconsin

KUNTZE, ERNEST A.
Sinclair Refining Co.
1316 S. Van Buren Street
Green Bay, Wisconsin

LADWIG, KENNETH E.
Ladish Drop Forge Co.
800 Milwaukee Avenue
South Milwaukee, Wisconsin

LAKE, THORNTON
F. D. Johnson Co.
F. D. Johnson Co.
1814 East 40th Street
Cleveland, Ohio

LAMPORT, BERT J.
United Eng. & Fdy. Co.
United Eng. & Fdy. Co.
1st National Bank Building
Pittsburgh, Pennsylvania

LANG, WALTER E.
Acheson Colloids Corp.
6523 Nottingham Street
St. Louis 9, Missouri

LANGWORTHY M. L.
The Texas Co.
The Texas Co.
135 East 42nd Street
New York 17, New York

LARSEN, ROBERT G.
Shell Development Co.
Shell Development Co.
Emeryville 8, California

LARSON, C.M.
Sinclair Refining Co.
Sinclair Refining Co.
630 Fifth Avenue
New York 20, New York

LAWRENCE, JOHN W.
Elco Lubricant Corp.
Elco Lubricant Corp.
Jennings and Dennison Streets
Cleveland 9, Ohio

LEADBETTER, JOHN MASON
McColl Frontenac Oil Co., Ltd.
McColl Frontenac Oil Co., Ltd.
1010 St. Catherine Street, West
Montreal, Canada

LEATHERS, H. M.
Dingle-Clark Co.
Dingle-Clark Co.
311 Ross Street
Pittsburgh 19, Pennsylvania

LEMPERT, FRANK C.
Tide Water Assoc. Oil Co.
Tide Water Assoc. Oil Co.
1510 Arrott Building
401 Wood Street
Pittsburgh 22, Pennsylvania

LENZ, EDWARD J.
Swan-Finch Oil Co.
Swan-Finch Oil Co.
735 North Water Street
Milwaukee, Wisconsin

LEONARD, WILLIAM F.
Studebaker Corp.—Aviation Division.
4541 Sheridan Road
Chicago, Illinois

LEROY, B. L.
Republic Steel Corp.
1128—17th Street, N. W.
Canton 3, Ohio

LEVALLY, JOHN R.
Lincoln Engineering Co. of Illinois.
Lincoln Engineering Co. of Illinois.
2415 South Michigan Avenue
Chicago 16, Illinois

LEY, RALPH M.
Shell Oil Co., Inc.
3240 South Burrell Street
Milwaulkee 7, Wisconsin

LICHTY, D. E.
National Refiining Co.
National Refiining Co.
621 South 12th Street
Milwaulkee 4, Wisconsin

LIEBER, EUGENE
Nox-Rust Chemical Corp.
Nox-Rust Chemical Corp.
2429 South Halsted Street
Chicago 8, Illinois

LIEBERMAN, ARTHUR ARNOLD
Petroleum Marketing Co.
1480 Darlene Drive
Box 335
La Habra Heights, California

LILLMARS, C. ARVID
Petroleum Equipment Co.
Petroleum Equipment Co.
3117 North Broad Street
Philadelphia, Pennsylvania

LINDQUIST, WILLIAM R.
Warren Refining and Chemical Co.
Warren Refining and Chemical Co.
5151 Denison Avenue
Cleveland, Ohio

LINK, G. H.
Shell Oil Co., Inc.
325 Mohawk Drive
Dearborn, Michigan

LINVILLE, WALLACE
General Petroleum Corp. of California
449 East Ramona Boulevard
Baldwin Park, California

LIVELY, THEODORE S.
The Texas Co.
12004 West Cherry Street
Milwaukee, Wisconsin

LOWRY, J. R.
Allegheny Ludlum Steel Corp.
Allegheny Ludlum Steel Corp.
Brackenridge, Pennsylvania

LUNDQUIST, JOSEPH T.
Lincoln Engineering Co.
7647 Phillips Avenue
Chicago 49, Illinois

LUNZ, GILBERT M.
Lincoln Engineering Co.
3035 West Wisconsin Avenue
Milwaukee 8, Wisconsin

LYKINS, JOSEPH D.
Wheeling Steel Co.
Wheeling Steel Co.
Yorkville, Ohio

MAAG, O. L.
Timken Roller Bearing Co.
Timken Roller Bearing Co.
Canton 6, Ohio

MADDEN, CYRIL A.
Pittsburgh Coal Co.
61 Union Avenue
Bellevue, Pennsylvania

MAGILL, F. R.
Sales Representative
1022 Empire Building
Pittsburgh, Pennsylvania

MAHNEKE, HENRY E.
Westinghouse Electric Corp.
Westinghouse Electric Corp.
East Pittsburgh, Pennsylvania

MANDY, W. H.
The Texas Co.
154 Spring Grove Road
Cresent Hills
Wilkinsburg, Pennsylvania

MANTEUFFEL, ALLAN A.
Pure Oil Research & Dev. Labs.
2122 Miner Street
Des Plaines, Illinois

MARIS, JOHN H.
L. R. Kerns Co.
L. R. Kerns Co.
4903 Delmar Boulevard
St. Louis 8, Missouri

MARSDEN, EARLE R.
National Refining Co.
1414 Lyon Street
Flint 4, Michigan

MATTHEWS, RALPH R.
Battenfeld Grease & Oil Co.
Battenfeld Grease & Oil Co.
3148 Roanoke Road
Kansas City 8, Missouri

MAZZARA, ERNEST E.
Cities Service Oil Co.
71 Madison Avenue
West Hempstead, New York

McCARTHY, PAUL R.
Gulf Research & Dev. Co.
Gulf Research & Dev. Co.
Hamarville, Pittsburgh, Pennsylvania

McCASLIN, R. H.
National Refining Co.
200 Eagle Point Road
Rossford, Ohio

McCLUNG, ERNEST E.
Van Straaten Chemical Co.
Van Straaten Chemical Co.
337 West Madison Street
Chicago 6, Illinois

McCUTCHEON, CURTIS A.
Sinclair Refining Co.
1100 Illinois Avenue
Pittsburgh, Pennsylvania

McDERMOTT, J. L.
Jos. T. Ryerson & Son, Inc.
621 De Walt Drive
Pittsburgh 16, Pennsylvania

McKEE, JOHN R.
Fiske Bros. Refining Co.
13817 North Drive
Cleveland 5, Ohio

McKIBBEN, ROBERT F.
National Cash Register Co.
241 North Smithville Street
Dayton 3, Ohio

McLENNAN, LESTER WINSTON
Union Oil Co. of California.
Union Oil Co. of California.
Oleum, California.

MEEHAN, JAMES J.
The Texas Co.
460 Moran Road
Grosse Pointe Farms, Michigan

MEIER, ANTON
The Weatherhead Co.
The Weatherhead Co.
300 East 131st Street
Cleveland 8, Ohio

MILLER, GEORGE W.
Battenfeld Grease & Oil Corp.
Battenfeld Grease & Oil Corp.
Box 144
North Tonawanda, New York

MILLER, HARRY L.
Haas-Miller Corp.
Haas-Miller Corp.
4th and Bristol Streets
Philadelphia 40, Pennsylvania

MONTALVO, EDWIN JAMES
James T. Gordon Co.
James T. Gordon Co.
233 Broadway
New York, New York

MOOK, ARTHUR D.
Aluminum Company of America
Aluminum Company of America
Lafayette, Indiana

MORGAN, EUGENE B.
Morgan Oil Co.
Morgan Oil Co.
Wyaconda, Missouri

MOUNTCASTLE, HENRY RICHARD
Swan-Finch Oil Corp.
1015 Jackman Avenue
Avalon
Pittsburgh 2, Pennsylvania

MUELLER, CARL H.
Lincoln Engineering Corp.
120 South Elizabeth Street
Ferguson 21, Missouri

MUELLER, JULIUS T.
Falk Corporation
Box 175
Hustisford, Wisconsin

MULHALL, JOHN
Thompson Aircraft Products Co.
3983 East 121st Street
Cleveland 5, Ohio

MURPHY, WILLIAM P.
Lubri-Zol Corp.
Lubri-Zol Corp.
Wickliffe, Ohio

MURRAY, J. P.
Dingle-Clark Co.
Dingle-Clark Co.
311 Ross Street
Pittsburgh, Pennsylvania

NEUHARDT, E. G.
Honan-Crane Corp.
Honan-Crane Corp.
Hotel Wheeling
Wheeling, West Virginia

NEWMAN, ALEXANDER I.
Precision Scientific Co.
Precision Scientific Co.
1750 North Springfield Avenue
Chicago 47, Illinois

NEWMAN, THOMAS HART ODELL
Esso Standard Oil, S. A.
Esso Standard Oil, S. A.
P. O. Box 28
Managua
Nicaragua, Central America

NINNEMANN, JOHN W.
Solventol Chem. Prod.
3437A—N. 46th Street
Milwaulkee 10, Wisconsin

NORGREN, CARL A.
C. A. Norgren Co.
C. A. Norgren Co.
222 Santa Fe Drive
Denver, Colorado

NORRIS, HENRY LEE
(Retired)
600 West 116th Street
New York 27, New York

NORRIS, WALTER
C. A. Norgren Co.
C. A. Norgren Co.
1251 West Fulton Street
Chicago 7, Illinois

O'FARRELL, ROBERT MAURICE
Standard Oil Co. of Trinidad, Ltd.
Standard Oil Co. of Trinidad, Ltd.
P. O. Box 233, Port of Spain
Trinidad, BWI

OLSEN, GODTFRED A.
Sunland Refining Corp.
Sunland Refining Corp.
P. O. Box 1512
Fresno 16, California

ORMSBY, GEORGE W.
Standard Oil Co. (Ind.)
2725 Brownell Boulevard
Flint 4, Michigan

ORTSTEIN, HERBERT L.
Pacific Mills
Pacific Mills
Lawrence, Massachusetts

O'SULLIVAN, EUGENE P.
The Texas Co.
The Texas Co.
332 South Michigan Avenue
Chicago 4, Illinois

PAAPE, LAWRENCE F.
Filmite Oil Corp.
2533 N. 97th Street
Wauwatosa 13, Wisconsin

PAGELS, EDWARD W.
W. J. Kramer
W. J. Kramer
923 South Fifth Street
Milwaukee, Wisconsin

PALMER, CHARLES
Morgan Construction Co.
Morgan Construction Co.
15 Belmont Street
Worcester 5, Massachusetts

PARCHE, WILLIAM HENRY
Carborundum Company
Carborundum Company
P. O. Box 337
Niagara Falls, New York

PARR, ALLEN R.
Oldsmobile Div.—Gen Mtrs Co.
808 McKinley Street
Janesville, Wisconsin

PASHEK, ALBERT L.
Socony Vacuum Oil Co., Inc.
1473 Alameda Avenue
Lakewood 7, Ohio

PEEBLES, JAMES CLINTON
Illinois Institute of Tech.
Illinois Institute of Tech.
3300 South Federal Street
Chicago 16, Illinois

PELLETIER, PAUL E., JR.
L. R. Kerns Co.
L. R. Kerns Co.
2657 E. 95th Street
Chicago 17, Illinois

PENFOLD, NORMAN C.
Armour Research Foundation
Armour Research Foundation
35 West 33rd Street
Chicago 16, Illinois

PENNEY, WILLIAM F.
Thompson Products, Inc.
Thompson Products, Inc.
2196 Clarkwood Avenue
Cleveland 3, Ohio

PENNOCK, WILLIAM T.
Alemite Sales Co., Inc.
559 Surf Street
Chicago 14, Illinois

PETERSON, CARL G.
Falk Corp.
2523 West Pierce Street
Milwaukee, Wisconsin

PETERSON, R. E.
Westinghouse Electric Corp.
Westinghouse Electric Corp.
East Pittsburgh, Pennsylvania

PERKINS, H. P.
The Texas Co.
S. 32nd Street and Bramar Road
Camp Hill, Pennsylvania

PETERSON, J. WILLARD
Standard Oil Co. (Ind.)
Standard Oil Co. (Ind.)
910 South Michigan Avenue
Chicago, Illinois

PFAFF, EDWIN I.
Trabon Engineering Corp.
Trabon Engineering Corp.
1814 East 40th Street
Cleveland 3, Ohio

PHILLIPS, KENNETH
Self
5153 Hillcrest Street
Pittsburgh 24, Pennsylvania

PLUME, WILLIAM F.
Phila. Gear Works, Inc.
Phila. Gear Works, Inc.
G St. below Erie Avenue
Philadelphia 34, Pennsylvania

POPSON, S. F.
Gulf Refining Co.
Gulf Refining Co.
1901 South 7th Street
Louisville 1, Kentucky

POTTER, RAYMOND I.
Standard Oil Co. (Ohio)
Standard Oil Co. (Ohio)
1784 Midland Building
Cleveland, Ohio

POULSON, H. R.
Johns-Manville
Johns-Manville
22 East 40th Street
New York, New York

POWERS, S. L.
Honan-Crane Corp.
Honan-Crane Corp.
606 Midland Building
Cleveland, Ohio

PRICE, DON C.
Bowser, Inc.
Bowser, Inc.
12652 Livernois Avenue
Detroit 4, Michigan

PRITCHARD, CHARLES E.
Republic Steel Corp.
Republic Steel Corp.
25 Prospect Street
Cleveland 1, Ohio

PRUDENT, HENRY J.
Jones and Laughlin Steel Corp.
Jones and Laughlin Steel Corp.
3341 Jennings Road
Cleveland 1, Ohio

PUGH, JAMES STRAYER
D-A Lubricant Co., Inc.
225 Carnegie Place
Pittsburgh, Pennsylvania

PULLMAN, WILLIAM LEROY
Utah Oil Refining Co.
Utah Oil Refining Co.
P. O. Box 898
Salt Lake City 10, Utah

RADOSEVICH, GEORGE E.
Harnischfeger Corp.
1622 South 13th Street
Milwaukee 4, Wisconsin

RAFFEL, FRANK H.
Republic Steel Corp.
3105 Stimson Court
Cleveland 9, Ohio

RAISIG, CHARLES
Mesta Machine Co.
Mesta Machine Co.
Homestead
Pittsburgh, Pennsylvania

RECTOR, GEORGE L.
Socony Vacuum Oil Co., Inc.
38 Terraceview Avenue
Pittsburgh 16, Pennsylvania

REGAN, ROBERT W.
Chrysler Corp.-Dodge Chi. Plant
1821 S. 50th Ct.
Cicero, Illinois

REHNBERG, ERNEST
Keystone Lubricating Co.
7015 Meade Street
Pittsburgh 8, Pennsylvania

RANDALL, MERLE
Randall and Sons
Randall and Sons
2512 Etna Street
Berkeley 4, California

REPENNING, ROBERT F.
Shell Oil Co., Inc.
918 Crain Street
Evanston, Illinois

RETTIG, MARION H.
Bowser, Inc.
Bowser, Inc.
E. Creighton Avenue
Ft. Wayne 5, Indiana

REYNOLDS, E. S.
Socony Vacuum Oil Co., Inc.
118 Cochran Road
Pittsburgh 16, Pennsylvania

RICHARDS, JOHN H., Jr.
Apex Alkali Prod. Co.
Apex Alkali Prod. Co.
Main and Rector Streets
Philadelphia 27, Pennsylvania

RIDGEWAY, R. K.
Honan-Crane Corp.
821 Parkside Avenue
Pittsburgh 16, Pennsylvania

RINEARSON, R. O.
The Warren Refining and Chemical Co.
The Warren Refining and Chemical Co.
5151 Denison Avenue
Cleveland 2, Ohio

ROBERT, F. C.
Gulf Oil Corp.
R. F. D. 1
Library, Pennsylvania

ROBERTS, EVAN J.
Hawley Plant AC Mfg. Co.
336 Wisconsin Avenue
Waukesha, Wisconsin

ROBERTSON, B. P.
Westinghouse Electric Corp.
1414 Coal Street
Pittsburgh 21, Pennsylvania

ROBISON, ROBERT V.
Dingle-Clark Co.
Dingle-Clark Co.
311 Ross Street
Pittsburgh, Pennsylvania

ROBSON, N. STEWART
F. D. Johnson Co.
F. D. Johnson Co.
1814 E. 40th Street
Cleveland, Ohio

ROEDER, CARL O.
Farval Corp.
Negley Hotel
Florence, Alabama

ROSENSTIEHL, FRED E.
The Texas Co.
The Texas Co.
135 East 42nd Street
New York 17, New York

ROSNELL, JOHN E.
The Texas Company
The Texas Company
332 South Michigan Avenue
Chicago 4, Illinois

ROSS, EDGAR S.
Sun Oil Co.
Sun Oil Co.
1608 Walnut Street
Philadelphia 3, Pennsylvania

ROSS, FRANK
E. F. Houghton and Co.
E. F. Houghton and Co.
4500 Euclid Avenue
Cleveland 3, Ohio

ROSS, F. R.
Alemite Co. of Pittsburgh
208 Charles Avenue
New Kensington, Pennsylvania

ROTERT, HARRY E.
Marquette Petroleum Products
Marquette Petroleum Products
7270 South Chicago Avenue
Chicago 19, Illinois

RUFFNER, ARTHUR F.
The J. W. Kelley Co.
The J. W. Kelley Co.
13209 Athens Avenue
Cleveland 7, Ohio

RUTMAN, GEORGE J.
Sta-Vis Oil Co.
Sta-Vis Oil Co.
184 Eagle Street
St. Paul, Minnesota

RYAN, TRUXTON B.
Dingle-Clark Co.
Dingle-Clark Co.
1600 Arch Street
Philadelphia 3, Pennsylvania

SAILER, ROMAN L.
Valvoline Oil Co.
548 Liberty Street
Franklin, Pennsylvania

SARGENT, F. J.
The National Refining Co.
The National Refining Co.
Hanna Building
Cleveland 15, Ohio

SAWYER, DAVID W.
Aluminum Research Labs.
525 South Braddock Avenue
Pittsburgh 21, Pennsylvania

SCHNEIDER, WILLIAM G.
Nordberg Mfg. Co.
Nordberg Mfg. Co...
3073 South Chase Avenue
Milwaukee 7, Wisconsin

SCHAFER, H. W.
D. A. Stuart Oil Co.
2235 North 60th Street
Wauwatosa, Wisconsin

SCHENCK, Rand G., Sr.
Fiske Brothers Refining Co.
614 Ridgefield Avenue
Pittsburgh 16, Pennsylvania

SCHMITT, C. R.
F. F. Houghton and Co.
F. F. Houghton and Co.
4500 Euclid Avenue
Cleveland 3, Ohio

SCHMOOK, ROBERT
Sinclair Refining Co.
5305 West Center Street
Milwaukee 10, Wisconsin

SCHROEDER, ELMER R.
Alemite Co. of Wis., Inc.
Alemite Co. of Wis., Inc.
1010 N. Van Buren Street
Milwaukee 2, Wisconsin

SCHULTZ, R. E.
Socony Vacuum Oil Co.
Socony Vacuum Oil Co.
907 South First Street
Milwaukee, Wisconsin

SCHWARTZ, DANIEL M.
Dravo Corporation
Dravo Corporation
Neville Island
Pittsburgh 25, Pennsylvania

SCOTT, CHARLES RALLYA
Wolf's Head Oil Ref. Co.
Wolf's Head Oil Ref. Co.
Fair Building
Oil City, Pennsylvania

SEELY, ROBERT S.
G. N. Crawford Equip Co.
G. N. Crawford Equip Co.
260—42nd Street
Pittsburgh, Pennsylvania

SETTLE, S. W.
Sun Oil Co.
Sun Oil Co.
3200 Independence Road
Cleveland, Ohio

SHAFFER, T. F.
Shell Oil Co., Inc.
1658 Victoria Road
Lakewood 7, Ohio

SHARPE, ROBERT Q.
Socony Vacuum Oil Co.
Socony Vacuum Oil Co.
59 East Van Buren Street
Chicago, Illinois

SICKELER, OLEN D.
Spang Chalfant Co.
Spang Chalfant Co.
Duss Avenue
Ambridge, Pennsylvania

SIMON, JOHN
Nat. Tube Co.
713 Wiley Avenue
McKeesport, Pennsylvania

SIPCHEN, JOHN H.
J. H. Sipchen and Co.
J. H. Sipchen and Co...
549 West Washington Boulevard
Chicago 6, Illinois

SKELLY, JAMES J.
Circo Products Co.
Circo Products Co.
2835 Chester Avenue
Cleveland 14, Ohio

SLAVIN, ERNEST F.
Ludlow Mfg. and Sales Co.
Ludlow Mfg. and Sales Co.
Ludlow, Massachusetts

SMALLEY, B. L.
L. R. Kerns Co.
11453 South Bell Street
Chicago 43, Illinois

SMITH, FRANK NEWELL
California Inst. of Tech.
252 South Catalina Street
Pasadena 5, California

SMITH, GEORGE L.
C. H. Clark Oil Company
1647 Holyoke Avenue
East Cleveland 12, Ohio

SMITH, JULIUS C.
Standard of California
Standard of California
225 Bush Street
San Francisco, California

SMITH, OSCAR W.
Socony Vacuum Oil Co., Inc.
Socony Vacuum Oil Co., Inc.
530 Hanna Building
Cleveland, Ohio

SMITH, PARKER B.
Socony Vacuum Oil Co.
Socony Vacuum Oil Co.
59 East Van Buren Street
Chicago 5, Illinois

SMITH, WILLIAM H.
Fiske Brothers Refining Co.
827 Forest Avenue
Evanston, Illinois

SNYDER, CHARLES H.
National Refining Company
2575 Whitelaw Avenue
Cuyahoga Falls, Ohio

STACK, JOHN W.
Standard Oil Co. (Ind.)
Standard Oil Co. (Ind.)
910 South Michigan Avenue
Chicago 80, Illinois

STALEY, CLAIR H.
Lincoln Engineering Co.
Lincoln Engineering Co.
134-6 South Whitfield Street
Pittsburgh 6, Pennsylvania

STATES, RONALD R.
N. Y. & N. J. Lubricant Co.
Anderson Road
Pittsburgh 15, Pennsylvania

STEINMETZ, SPENCER J.
Cities Service Oil Co.
501 West Main Street
Crawfordsville, Indiana

STILLWAGON, MARK A.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
Homestead, Pennsylvania

STILWELL, WILLIAM MOORE, JR.
Dingle-Clark Co.
Dingle-Clark Co.
1600 Arch Street
Philadelphia 3, Pennsylvania

STOCKER, K. K.
Sun Oil Co.
Sun Oil Co.
3205 Grant Building
Pittsburgh, Pennsylvania

STRANAHAN, L. H.
White Motor Co.
White Motor Co.
842 East 79th Street
Cleveland 1, Ohio

STROHMAIER, ALFRED J:
E. I. duPont deNemours & Co.
E. I. duPont deNemours & Co.
1007 Market Street
Wilmington 98, Delaware

SUMMERS, HARRY K.
Thompson Aircraft Products, Inc.
1776 N. Taylor Road
East Cleveland 12, Ohio

SUMNER, GEORGE L.
Westinghouse Electric Corp.
Westinghouse Electric Corp.
East Pittsburgh, Pennsylvania

SUNDERLAND, RICHARD P.
General Meters & Controls Co.
General Meters & Controls Co.
205 West Wacker Drive
Chicago 6, Illinois

SVENSON, E. B.
Aluminum Company of America
Aluminum Company of America
New Kensington, Pennsylvania

SVENSON, ELMER B., JR.
National Tube Co.
P. O. Box 85
McKeesport, Pennsylvania

SWIFT, CLINTON E.
Greenleaf Corp.
593 Chestnut Street
Meadville, Pennsylvania

SYLVESTER, FRANK A.
Supercharger Works—Allis Chalmer
5425 West Martin Drive
Milwaukee 8, Wisconsin

SYMON, B. G.
Shell Oil Co., Inc.
Shell Oil Co., Inc.
50 West 50th Street
New York 20, New York

TALLEY, S. K.
Shell Development Co.
Shell Development Co.
4560 Horton Street
Emeryville 8, California

TAYLOR, ARTHUR J.
Johns Manville Corp.
Johns Manville Corp.
Manville, New Jersey

TAYLOR, J. I. C.
Sun Oil Co.
807 Heberton Street
Pittsburgh 6, Pennsylvania

TAYLOR, O. J.
Gulf Oil Corp.
503 Warren Avenue
Apollo, Pennsylvania

TESSMAN, H. R.
Barber-Colman Company
Barber-Colman Company
150 Loomis Street
Rockford, Illinois

THOMAS, DUDLEY P.
U. S. Navy
U. S. Markab
c/o F. P. O.
San Francisco, California

THORKELSON, R. H.
Dingle-Clark Co.
Dingle-Clark Co.
1248 Engineers Building
Cleveland 14, Ohio

THUREN, ARTHUR I.
Swan-Finch Oil Corp.
7206 South Shore Drive
Chicago 49, Illinois

TOWNSEND, F. LEE
Wm. W. Nugent & Co.
6151 Winthrop Avenue
Chicago 40, Illinois

TURPIN, PAUL L.
Lincoln Engineering Co.
9917 South Bell Avenue
Chicago 43, Illinois

TYLER, CLINTON S.
Socony Vacuum Oil Co., Inc.
2201 Ridge Avenue
Evanston, Illinois

UNGER, C. D.
Atlantic Refininfi Co.
79 Grant Avenue
Pittsburgh 2, Pennsylvania

UNKS, L. T.
Sun Oil Co.
Sun Oil Co.
3200 Independence Street
Cleveland, Ohio

URSEM, WILLIAM A.
F & W Ursem Company
F & W Ursem Company
1548 West 117th Street
Cleveland 7, Ohio

VARETONI, WILLIAM J.
Cities Service Oil Co.
Industrial Oil Manager
660 Beacon Street
Boston, Massachusetts

VILLING, JOHN A.
Valvoline Oil Company
163 Oak Street
Butler, Pennsylvania

VON FUCHS, GEORGE H.
Shell Oil Company, Inc.
Shell Oil Company, Inc.
Wood River, Illinois

VON MAYRHAUSER, BENNO
Shell Oil Company, Inc.
Shell Oil Company, Inc.
Wood River, Illinois

WADDELL, J. N.
Henry H. Cross Co.
Henry H. Cross Co.
122 South Michigan Avenue
Chicago 3, Illinois

WALLACE, G. W.
Freedom Oil Co.
Freedom Oil Co.
Freedom, Pennsylvania

WALSH, JOSEPH D.
Rex Oil and Chemical Co.
Rex Oil and Chemical Co.
9120 Loren Avenue
Cleveland 5, Ohio

WALSTRA, JESSE C.
L. R. Kerns Co.
L. R. Kerns Co.
2657 East 95th Street
Chicago 17, Illinois

WARD, DAMIEN J.
Alemite Sales Co.
8015 Merrill Avenue
Chicago 17, Illinois

WARNER, JOHN T.
Carnegie-Illinois Steel Corp.
Carnegie-Illinois Steel Corp.
Gary, Indiana

WEGMAN, THEO. H.
A. O. Smith Corp.
3608 North 27th Street
Milwaukee 10, Wisconsin

WEHKING, FRANK J.
U. S. Navy
730 Jackson Street
Gary, Indiana

WEIGHT, JAMES CLINTON
Standard Oil Co. (N. J.)
R. D. No. 2
Coopersburg, Pennsylvania

WEIGHTMAN, ALBERT EDWARD
Tidewater Oil Co. of Canada, Ltd.
Tidewater Oil Co. of Canada, Ltd.
201 Weston Road, South
Toronto, Canada

WEINKAUF, C. E.
Hodson Corp.
1020 Old Gate Road
Wilkinsburg 21, Pennsylvania

WELCH, L. C.
Sandard Oil Co. (Ind.)
Sandard Oil Co. (Ind.)
910 South Michigan Avenue
Chicago 80, Illinois

WELLER, ARNO L.
Farval Corp.
Farval Corp.
327 S. LaSalle Street
Chicago, Illinois

WENDT, PAUL W.
Grafo Colloids Corp.
Grafo Colloids Corp.
431 South Dearborn Street
Chicago 5, Illinois

WESTRA, JACK MITCHELL
Honan-Crane Corp.
6336 Drexel Avenue
Chicago, Illinois

WHITE, NELSON E.
Warren Refining and Chemical Co.
Warren Refining and Chemical Co.
308 Euclid Avenue
Cleveland 4, Ohio

WHITE, W. HARRY
The Atlantic Refining Co.
557 South Braddock Avenue
Pittsburgh 21, Pennsylvania

WHITEHEAD, DONALD E.
Carnegie Illinois Steel Corp.
Carnegie Illinois Steel Corp.
Carnegie Building
Pittsburgh, Pennsylvania

WHITELEY, N. I.
Cities Service Oil Co.
Cities Service Oil Co.
3200 South Western Avenue
Chicago 8, Illinois

WICOFF, J. R.
Farval Corp.
Farval Corp.
327 South LaSalle Street
Chicago 4, Illinois

WIEDLING, CLARENCE C.
Socony Vacuum Oil Co., Inc.
Socony Vacuum Oil Co., Inc.
59 East Van Buren Street
Chicago 5, Illinois

WILBERT, FRANK, JR.
Waverly Oil Works Co.
Waverly Oil Works Co.
54th Street and A. V. R. R.
Pittsburgh 1, Pennsylvania

WILKINSON, RALPH E.
Aro Equipment Corp.
Aro Equipment Corp.
231 West Wisconsin Avenue
Milwaukee 3, Wisconsin

WILLIAMS, DEWEY L.
Cities Service Oil Co.
R. D. No. 1—Verona Road
Pittsburgh, Pennsylvania

WILLSON, EDWARD A.
Grafo Colloids Corp.
Grafo Colloids Corp.
310 Wilkes Place
Sharon, Pennsylvania

WILSON, DONALD H.
Continental Steel Corp.
Continental Steel Corp.
South Plant
Kokomo, Indiana

WINTER, WILLIAM R.
Standard Oil Co. (Ind.)
2645 Pasadena Boulevard
Wauwatosa 13, Wisconsin

WIRTH, FLOYD J.
Cities Service Oil Co.
Cities Service Oil Co.
6611 Euclid Avenue
Cleveland, Ohio

WITHROW, RAYMOND C.
Freedom Oil Co.
Freedom Oil Co.
902 Peoples Bank Building
Pittsburgh, Pennsylvania

WOLMER, CHARLES E.
Armour Research Foundation
Armour Research Foundation
35 West 33rd Street
Chicago 16, Illinois

WOOD, FRANK J.
Goodman Manufacturing Co.
Goodman Manufacturing Co.
4834 South Halsted Street
Chicago, Illinois

WOOD, R. LEE
Hodson Corp.
1458 Argyle Street
Chicago 40, Illinois

WORLEY, ROBERT B.
Warren Refining and Chemical Co.
Warren Refining and Chemical Co.
308 Euclid Avenue
Cleveland 14, Ohio

WRIGHT, JOSEPH PRESTON
Cities Service Oil Co.
205 North Greenfield Street
Waukesha, Wisconsin

WRIGHT, W. ANDREW
Sun Oil Co.
Sun Oil Co.
Marcus Hook, Pennsylvania

WRIGHT, WILLIAM J.
Gulf Refining Co.
Gulf Refining Co.
Maison Blanche Building
New Orleans 16, Louisiana

YODER, H. F.
Gulf Refining Co.
154 Bryn Mawr Drive
Cincinnati 24, Ohio

YOUNGCLAUS, WILLIAM P., JR.
Dodge Chicago Plant, Chrysler Corp.
2114 Fir Street
Glenview, Illinois

ZINO, ANTHONY JOSEPH, JR.
E. F. Houghton and Co.
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Manhasset, New York

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Youngstown, Ohio
Mr. Wm. Rodder

ALUMINUM CO. OF AMERICA
New Kensington, Pennsylvania
Dr. E. M. Kipp

CARNEGIE-ILLINOIS STEEL CORP.
Carnegie Building
Pittsburgh 30, Pennsylvania
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Midland, Michigan
Mr. E. F. Graves

FARVAL CORP.
3249 E. 80th Street
Cleveland 4, Ohio
Mr. A. J. Jennings

HODSON CORP.
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Chicago 38, Illinois
Mr. W. D. Hodson

INLAND STEEL CO.
38 South Dearborn Street
Chicago 3, Illinois
Mr. D. N. Evans

L. R. KERNS CO.
2657 E. 95th Street
Chicago, Illinois
Mr. L. R. Kerns

LINCOLN ENGINEERING CO.
5701 Natural Bridge Avenue
St. Louis, Missouri
Mr. A. P. Fox

LUBRI-ZOL CORP.
Box 3057 Euclid Station
Cleveland 17, Ohio
Mr. Arthur O. Willey

REPUBLIC STEEL CORP.
Republic Building
Cleveland, Ohio
Mr. C. E. Pritchard

REX OIL AND CHEMICAL CO.
9120 Loren Avenue
Cleveland 5, Ohio
Mr. J. D. Walsh

SHELL OIL CO., INC.
New York, New York
Mr. B. J. Symon

SOCONY-VACUUM OIL CO., INC.
26 Broadway Avenue
New York 4, New York
No representative appointed

STANDARD OIL CO. OF CALIFORNIA
Standard Oil Building
San Francisco 20, California
Mr. C. J. Smith

STEWART-WARNER CORP.
1826 Diversey Parkway
Chicago, Illinois
Mr. C. I. Kraus

SUN OIL CO.
1608 Walnut Street
Philadelphia 3, Pennsylvania
Dr. E. S. Ross

SWAN-FINCH OIL CORP.
R. C. A. Building, West
New York 20, New York
Mr. S. W. Bodman

TENNESSEE COAL, IRON AND RAILROAD CO.
Birmingham, Alabama
Mr. E. J. Kohn

TRABON ENGINEERING CORP.
1814 East 40th Street
Cleveland 3, Ohio
Mr. E. I. Pfaff

WESTINGHOUSE ELECTRIC CORP.
Research Laboratory
East Pittsburgh, Pennsylvania
Mr. R. E. Peterson

**In accordance with the American Society of Lubrication Engineers Constitution each sustaining member company names one man as its official representative. The names of men thus appointed are indicated in italics.*

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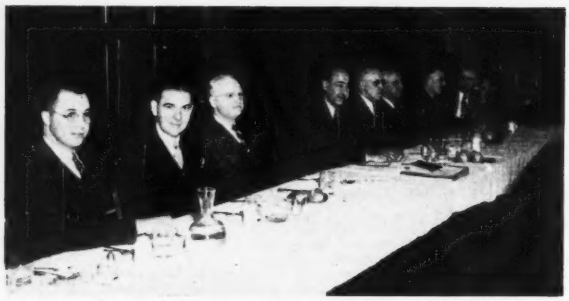
NEWS of the

Chicago Section

Old and New Officers of the Chicago Section. Left to right: Robert Q. Sharpe, new Secretary-Treasurer; D. N. Evans, new Vice Chairman; W. F Leonard, new Chairman; C. A. Bailey, former Chairman; E. J. Ehret, retiring Secretary-Treasurer; seated, H. E. Bergman, guest speaker.



Group at the Chicago Meeting October 8th. Left to right. D. N. Evans, G. W. Bowers, C. A. Bailey, E. J. Ehret, H. E. Bergman, W. D. Hodson, Don Wilson, A. W. Green.

The Chicago Section met November 28th and, in addition to hearing two fine papers, carried out the election of its new officers.

Chairman Charles A. Bailey opened the meeting and called on Secretary and Treasurer E. J. Ehret for the financial report of the current year. Following this, he introduced Mr. H. E. Bergman of Bowser, Inc., who delivered a very interesting paper on "Turbine Oil Maintenance Systems." Following this paper, Mr. George F. Bowers of the Standard Oil Company of Indiana, delivered a paper on the subject of "Standardization." Both topics proved of real interest to the audience and numerous questions were asked. Mr. Bowers is Chairman of the Standards Committee of the Chicago Section of the A.S.L.E.

The nominees were then presented and unanimously elected. Mr. W. F. Leonard of the Studebaker Corporation is the new Chairman, Mr. D. N. Evans of the Inland Steel Company is the new Vice-Chairman, and Mr. R. Q. Sharpe of the Socony-Vacuum Oil Company is the new Secretary-Treasurer.

It was moved and passed that the present Officers of the Chicago Section constitute an Advisory Committee for the following year.

Pittsburgh Section

Mr. Wilbur Deutsch, Secretary of the Pittsburgh Section, sends us the following report of the meeting held November 16th at the Hotel Webster Hall.

The meeting was attended by 61 people and was preceded by a dinner. With Chairman B. J. Lamport presiding, the minutes of the last meeting were approved as read and Mr. Lamport announced the appointment of Joseph D. Lykins as Chairman of the Membership Committee for the balance of the year.

E. B. Svenson, Jr., brought up the subject of the Pennsylvania Professional Engineers License. Messrs. Lamport, Bullions, and E. B. Svenson, Sr., commented. Chairman Lamport appointed C. S. Satter to get further details on the subject to report.

The annual election was announced for the meeting on January 18, 1946. A Nominating Committee was appointed consisting of George L. Summer, D. E. Whitehead, and Charles Taylor; George Sumner to act as Chairman and three names to be submitted for each office. The offices of Secretary and Treasurer are to be combined.

In the absence of Chairman Fink of the Entertainment Committee, the Secretary announced that a party would be held after the December 14th meeting. Prizes were requested for use at the Golf Party. Refreshments are to be served.

The meeting was then turned over to Mr. E. B. Svenson, Sr., Chairman of the Program Committee who announced that the Texas Company sound pictures, "Deep Horizon," would be shown at the December 14th meeting.

Mr. Svenson then introduced Dr. Henry Mahnche of the Westinghouse Research Laboratories who gave a paper on "What is a Lubricant?"

A discussion followed the papers, after which the meeting was adjourned.

Cleveland-Youngstown Section

Mr. L. W. Fitch, Secretary-Treasurer of the Cleveland-Youngstown Section, reports that a fine meeting was held on October 31st, at which Mr. Oscar C. Thomas spoke on "Engines and Oils in Wartime Britain." This very interesting paper is published this month in LUBRICATION ENGINEERING and is well worth reading if you did not have a chance to hear Mr. Thomas in person.

At the November 27th meeting held at the Engineering Society, Mr. Oscar Maag was scheduled as the speaker, but at the time of going to press the complete report on this meeting had not yet been received by the Editor.

Milwaukee Section

The Milwaukee Section met Monday, November 19th, at the Red Arrow Club, and heard an interesting address by Mr. Walter P. Schmitter, Chief Engineer of the Falk Corporation, upon the subject of "Gear Lubrication."

Following the talk and the consequent discussion, a movie, entitled "Victory's Oil" was shown.

SECTIONS

Philadelphia Section

A group in Philadelphia is now making active progress leading to the formation of a Section in that City.

On Monday night, December 3rd, a meeting was held in the conference room of the Insurance Company of North America, 1600 Arch Street. At this meeting, Mr. D. F. Hollingsworth of DuPont deNemours and Company, and Mr. T. B. Ryan of the Dingle Clark Company, acted as Co-Chairmen for the 21 interested members and guests who were present.

Mr. Ryan, in reporting the meeting, stated that this was opened with a roll call during which the men introduced themselves and gave their company affiliation. It was then explained that the purpose of the meeting was to determine if there was proper interest in forming a preliminary organization of a Philadelphia Section of the American Society of Lubrication Engineers.

Mr. Hollingsworth followed with a short history on the American Society of Lubrication Engineers from its beginning until the present time.

This was followed by a short talk by Dr. E. S. Ross explaining the purpose of the Society.

Mr. Ryan then explained what is being done in the other Society Sections. This consisted of describing the type of meetings held, type of papers, etc., from information forwarded by Mr. Charles Bailey of Chicago, Mr. C. A. Bierlein of Cleveland, and Mr. Wilbur Deutsch of Pittsburgh.

The meeting was then opened for questions from those present. It was evident, after the question session, that there was sufficient interest to enable a temporary organization to be set up. A motion was made by Mr. N. B. Conover that a temporary organization be set up and this was seconded by Mr. I. E. Owens.

It was then decided that the temporary organization would consist of a temporary Chairman and temporary Secretary. Dr. E. S. Ross made a motion that Mr. Hollingsworth be the temporary Chairman and Mr. Ryan the temporary Secretary. This motion was seconded by Mr. A. J. Strohmaier and both motions were passed. It was understood that Mr. Hollingsworth would appoint an organization-nominating committee and a finance and membership committee. It was further explained that Mr. Hollingsworth and Mr. Ryan were to be temporary officers acting in this capacity until a general election could be held at the next meeting.

Applications for membership blanks were then given to the gentlemen who were not, at that time, members of the National Organization.

The meeting closed at 10:30 P.M.

New York Section

An organizational meeting for a Section in New York was held at the New York Athletic Club on Monday, October 22nd. At this meeting 14 were in attendance, consisting of members of the Society with a few guests.

Mr. W. D. Hodson of the Chicago Section spoke to the group about the National Society, as did also Mr. C. M. Larson of New York.

After the general talks and the subsequent discussion, all present expressed a sincere desire to form a Section in the New York Area and a Nominating Committee was appointed which later in the meeting selected the following men for Officers of the Section:

Chairman—Mr. D. D. Fuller, Associate Professor, Dept. Mechanical Engineering, Columbia University.

Vice Chairman — Mr. Henry Lee Norris, M. E., Retired Director, Columbia University, Consulting Engineer.

Secretary-Treasurer—Mr. A. J. Zino, Jr., Manager, Lubrication Dept., Eastern Division, E. F. Houghton and Co.

Following the meeting, the Secretary, Mr. Zino, applied to President Pritchard for formal authorization to form the New York Section and this authorization was granted by President Pritchard on November 7.

The National Society is happy to welcome this newest group to its ever-growing list of Local Sections.

A.S.L.E. Section Officers

CHICAGO:	Chair., Mr. W. F. Leonard, 4541 Sheridan Rd., Chicago, Ill. V. Chair., Mr. D. N. Evans, Inland Steel Co., E. Chicago, Ind. Secy.-Treas., Mr. R. O. Sharpe, Socony-Vacuum Oil Co., 59 E. Van Buren St., Chicago, Ill.
CLEVELAND-YOUNGSTOWN:	Chair., Mr. C. A. Bierlein, G. M. C., Cleveland Diesel Engine Div., 2160 W. 106th St., Cleveland 11, Ohio. V. Chair., Mr. R. J. Hagan, Republic Steel Co., Youngstown 1, Ohio. Secy.-Treas., Mr. L. W. Fitch, Dingle-Clark Co., 1248 Engineers Bldg., Cleveland 14, Ohio.
MILWAUKEE:	Chair., Mr. W. H. Krause, Allis-Chalmers Mfg. Co., 711 S. 3rd St., Milwaukee 14, Wisc. V. Chair., Mr. O. Frohman, 4478 N. Cramer St., Milyaukee 11, Wisc. Secy., Mr. W. A. Alexandroff, 2637 N. 69th St., Milwaukee 13, Wisc. Treas., Mr. R. E. Schultz, Socony-Vacuum Co., Inc., Wadhams Div., 907 First St., So., Milwaukee, Wisc.
NEW YORK:	Chair., Mr. D. D. Fuller, Dept. of Mech. Eng., Columbia Univ., New York 27, N. Y. V. Chair., Mr. Henry Lee. Secy.-Treas., Mr. A. J. Zino, 27 Shoreview Rd., Manhasset, N. Y.
PHILADELPHIA:	Chair., Mr. D. F. Hollingsworth, E. I. duPont de Nemours & Co., 1007 Market St., Wilmington 98, Del. Secy.-Treas., Mr. T. B. Ryan, Dingle Clark Co., 1600 Arch St., Philadelphia 3, Pa.
PITTSBURGH:	Chair., Mr. B. J. Lamport, United Eng. & Foundry Co., 1st Nat'l Bank Bldg., Pittsburgh, Pa. V. Chair., Mr. E. B. Svenson, Jr., P. O. Box 85, McKeesport, Pa. Secy., Mr. Wilbur Deutsch, Trabon Engrg. Corp., 1022 Empire Bldg., Pittsburgh 22, Pa. Treas., Mr. O. L. Brandes, Gulf Research & Development Co., P. O. Box 2038, Pittsburgh 30, Pa.

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of

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N. C. PENFOLD
D. D. FULLER
W. S. MCKEE

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Inland Steel Company
East Chicago, Indiana
B. H. JENNINGS, ex-officio

Membership Committee:

C. A. BAILEY, Chairman
Carnegie-Illinois Steel Corp.
Gary Works
Gary, Indiana

By-Laws Committee:

D. E. WHITEHEAD, Chairman
Carnegie Illinois Steel Corp.
Carnegie Building
Pittsburgh, Pa.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Grades of Membership

Membership in the Society is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

MEMBER

A member shall be not less than twenty-four (24) years of age. A member must have occupied a recognized position in the practice of lubrication engineering for a period of not less than three (3) years at some period prior to the date of admission, involving the responsibility for, or supervision of, the development, selection, field use and application of lubricants as differentiated from other activities, or he must have engaged in research or instruction at technical schools, universities, and various publicly and privately supported institutions, on the subject of lubrication.

$10.00

ASSOCIATE MEMBER

An associate member shall be not less than twenty-four (24) years of age. Associate members are persons who are indirectly concerned with the applications of lubrication but, qualified by experience, knowledge and accomplishment, have manifested a particular interest in the purpose and welfare of the Society to the extent that their membership would be a valuable contribution to the successful functioning of its activities. In general, executives not directly concerned with the use of lubricants or those whose major interest is in the field of lubricant manufacture, sales of lubricants, or promotional activity associated with lubricants will be classed as associate members.

$10.00

JUNIOR MEMBER

Junior members shall be persons of less than twenty-four (24) years of age, or those over twenty-four (24) years of age whose activities place them in the member group but whose background does not yet let them qualify under the three (3) year period of responsibility in the field of lubrication.

$5.00

SUSTAINING MEMBERS

Sustaining members are such persons or organizations as may be interested in and desire to contribute to supporting the purposes and activities of the Society. The fees paid by a sustaining member in general will not be allowed to exceed $200.00 per year.

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Lubricant Producer ☐ Servicing ☐ Other ☐

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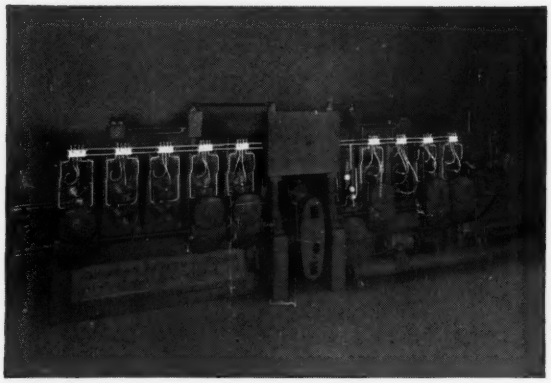
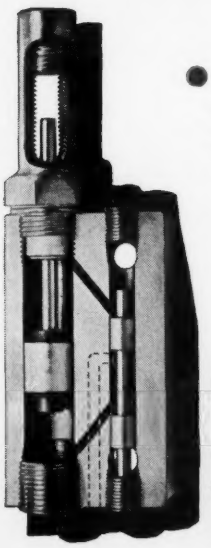
2. Cut shutdowns for repairs
3. Save lubricant
4. Save power
5. Save repair costs
6. Increase production
7. Reduce rejections
8. Avoid accidents
9. Make machines last longer

adds up to

✓ **increased production**
✓ **reduced costs**
✓ **better profit margins**





● *Farval—the Dualine System with the Positive Piston Displacement Valve —that has but 2 Moving Parts—is Fully Adjustable—with a Tell-tale at each bearing to show the job is done.*

Hand lubrication is a threat to profits. Some bearings can get too much and others too little—many bearings may be overlooked entirely.

Install Farval Centralized Lubricating Systems and you can *concentrate on production.* Because with Farval you deliver measured amounts to every bearing—no matter how high up or how deeply "buried" —from one safe Central Pumping Unit.

Be particular in selecting your lubricants—but be just as particular to see that they *get to your bearings,* to maintain a continuous film at all times. There's a suitable Farval System to help increase production on every machine in your plant—and a Farval Representative near you to plan the correct applications. *Send for him.*

The Farval Corporation, 3267 East 80th Street, Cleveland 4, Ohio.

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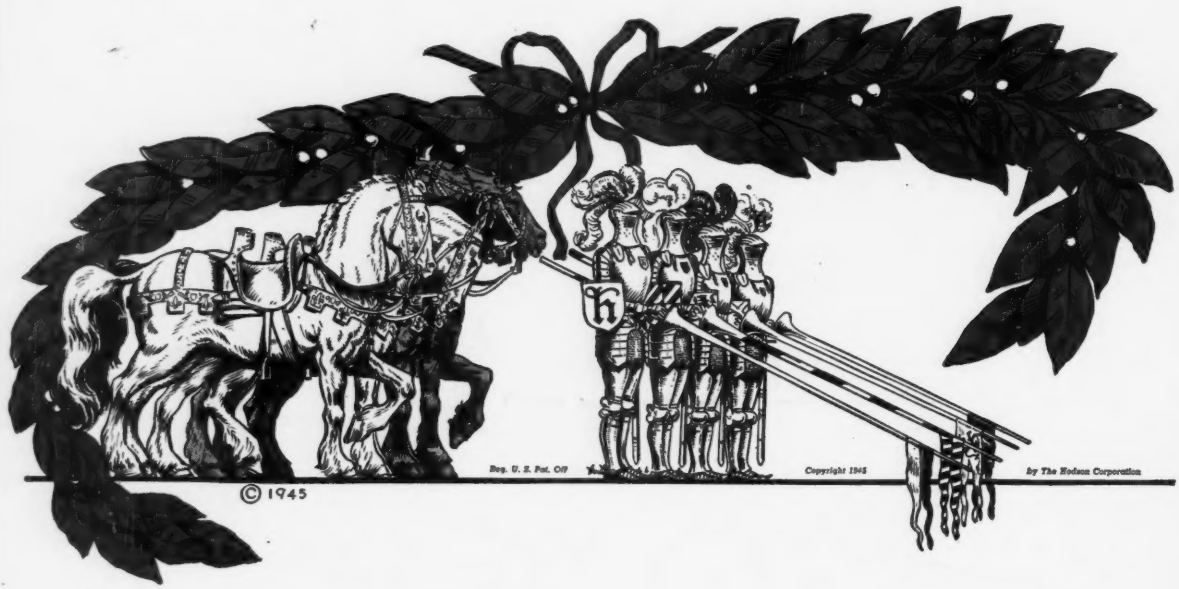

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